SYNTHESIS OF 2-SUBSTITUTED 2,3-DIHYDRO-9-PHENYL-1H-PYRROLO[3,4-b]QUINOLIN-3-ONES AS POTENTIAL PERIPHERAL BENZODIAZEPINE-RECEPTOR LIGANDS

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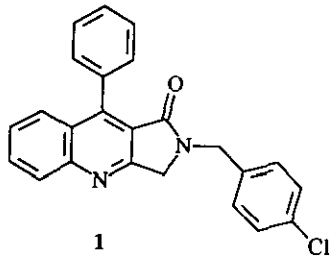
Abstract - Two synthetic routes to the achievement of the title compounds are described. 2-Chloromethyl-3-ethoxycarbonyl-4-phenylquinoline (4) was transfomed into the corresponding lacton (5) which in two steps was converted into its isomeric lacton (7). Aminolysis of 7 gave γ-hydroxyamide (8) which was in turn transformed into γ-chloroamide (9). Cyclization of 9 with sodium hydride in presence of oxygen led to the oxidized compound (10), while by carrying out the cyclization reaction under inert atmosphere, 2-benzyl-2,3-dihydro-9-phenyl-1H-pyrrolo[3,4-b]quinolin-3-one (3a) was obtained. Autoxidation of anion at 1-position of compound (3a) was considered to account for these results and a mechanistical interpretation was given. A simplier and more versatile route to obtain the title compounds was also developed.

In a previous paper we reported on the synthesis and benzodiazepine-peripheral type receptor affinities of some 2,3-dihydro-9-phenyl-1H-pyrrolo[3,4-b]quinolin-1-one derivatives.[1] Among them compound (1) showed good affinity for the above-mentioned receptor and none for the central type. As in an european patent Dubroeucq and coworkers claimed the high affinities of compounds (2) for the peripheral benzodiazepine receptors,[2] we became interested in developing a general synthetic methodology to obtain 2,3-dihydro-9-phenyl-1H-pyrrolo[3,4-b]quinolin-3-one derivatives (3) which could be regarded as rigid analogues of compounds (2).



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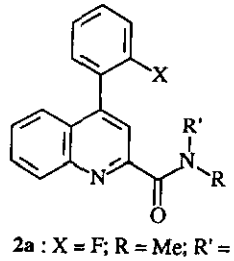
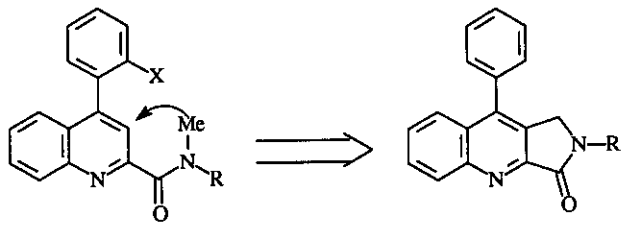


2a : X = F; R = Me; R' = sec-Bu
2b : X = H; R = R' = Et



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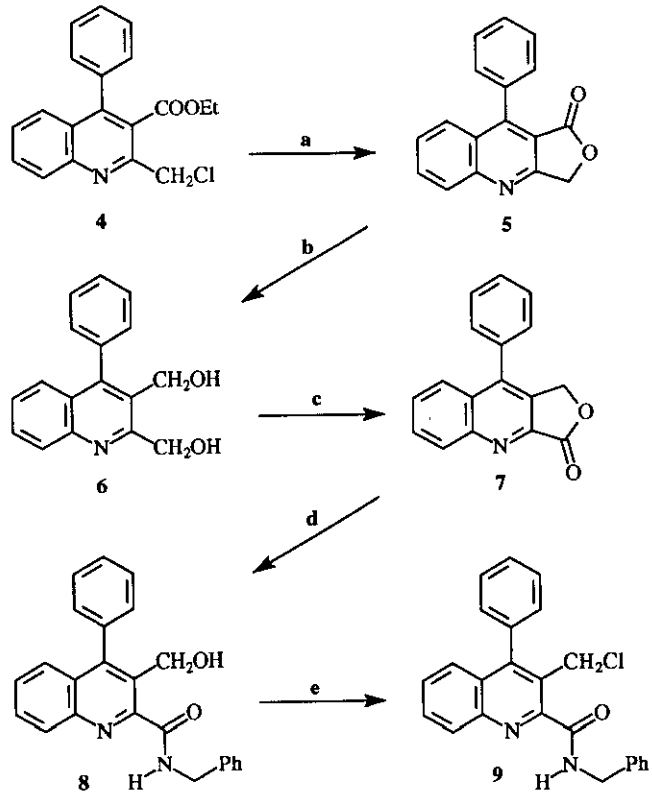
3a : X = H; R = CH_2Ph
3b : X = H; R = CH_2-(p-ClC_6H_4)
3c : X = H; R = sec-Bu

An early paper [3] reported the synthesis of 2-benzyl-2,3-dihydro-9-phenyl-1H-pyrrolo[3,4-b]quinolin-3-one (3a), but for our pourposes this methodology is not sufficently versatile because it requires a different N-substituted 2,3-dioxopyrrolidine when R changes. Our synthetic strategy consisted in the shifting of R-insertion in the last steps of the process in order to achieve a more versatile synthetic methodology. The first approach to the synthetic intermediates of compound (3a) is depicted in Scheme 1.

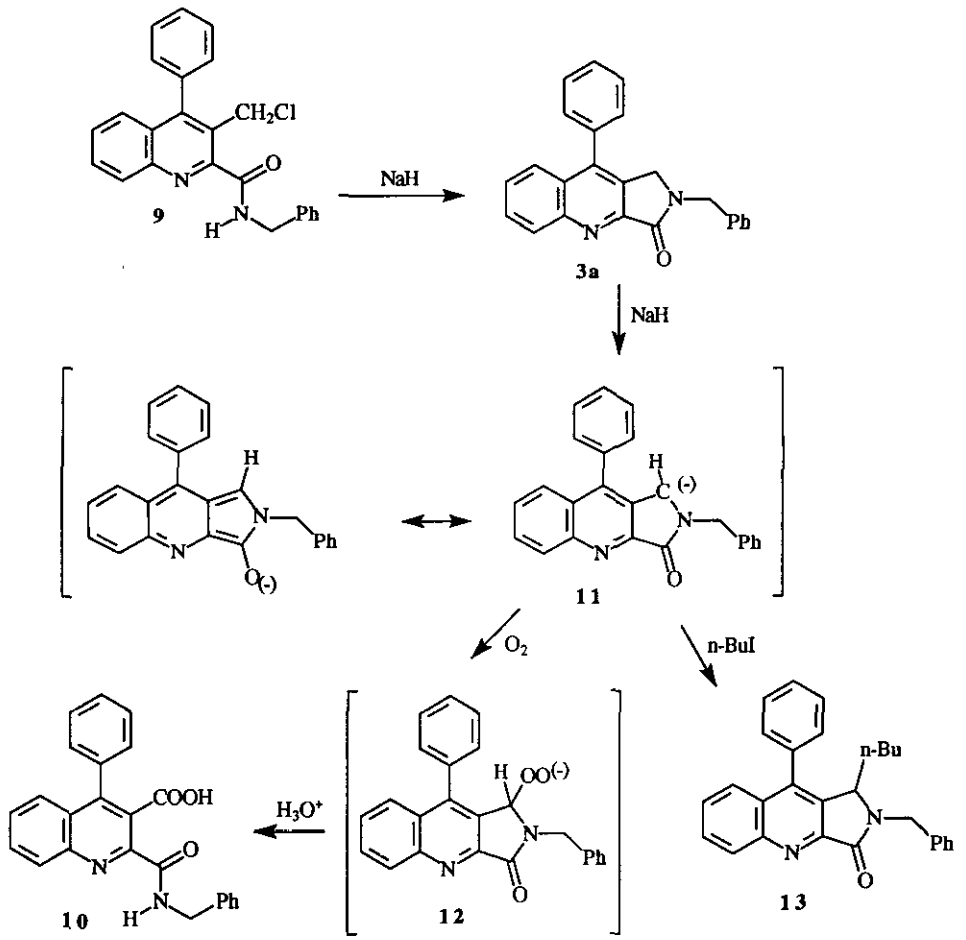
Scheme 1



Reagents: **a**, HCl/H_2O/EtOH; **b**, 1)LAH/THF 2)Pd/C/EtOH; **c**, MnO_2/CH_2Cl_2
d, $PhCH_2NH_2$/EtOH; **e**, $SOCl_2/CH_2Cl_2$

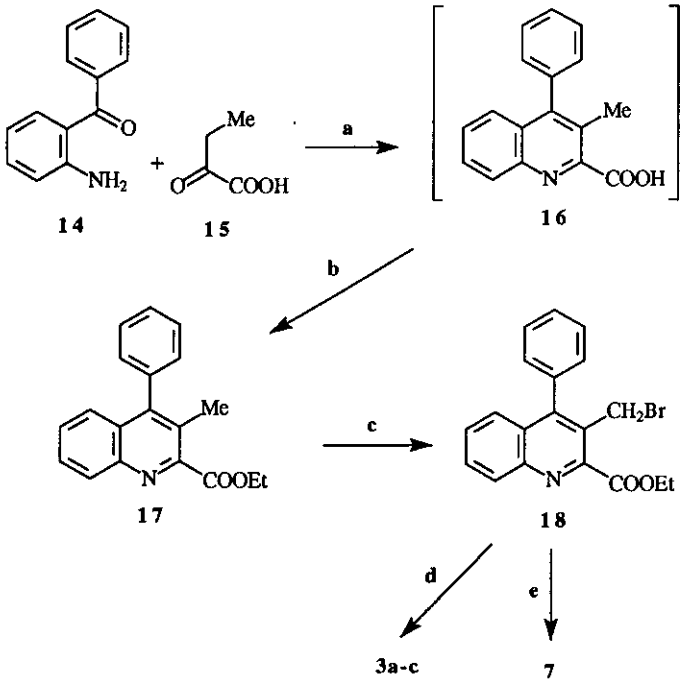
The 4-phenylquinoline derivative (4), readily accessible by acid-catalyzed Friedländer condensation from benzophenone and ethyl 4-chloroacetoacetate as reported in one of our previous papers, [4] was used as starting material. By refluxing compound (4) in ethanolic aqueous hydrochloric acid lacton (5) [5] was obtained in good yield. Lithium aluminium hydride reduction of 5 produced, beside the expected diol (6) a considerable amount of an unidentified dihydroquinoline which was dehydrogenated to diol (6) by treatment with palladium on carbon. Oxidation of 6 with manganese dioxide in dichloromethane proceeded with a high degree of regiospecificity and the isomeric lacton (7) only was obtained. This result could be rationalized by taking into account the electron withdrawing effect elicited by the quinoline nucleus which activates the hydroxymethylene group in position 2 rather than that in position 3 . Aminolysis of compound (7) with benzylamine in refluxing ethanol led to the γ-hydroxyamide (8) and by further treatment with thionyl chloride in dichloromethane 9 was obtained. The first attempt to cyclize γ-chloroamide (9) in presence of an excess of sodium hydride in N,N-dimethylformamide at room temperature for an hour led to the oxidized compound (10) (Scheme 2).

Scheme 2



A careful check of reaction trend by tlc revealed that γ-lactam (3a) was formed within few minutes and disappeared from the chromatogram after 45-60 minutes. Compound (3a) was obtained in good yield by rigorous exclusion of oxygen from the reaction medium. Probably compound (3a), initially formed from 9 by intramolecular displacement of the chlorine atom of the chloromethyl group, was converted by excess sodium hydride, into the corresponding extensively delocalized anion (11).[6] This resonance stabilized anion could easily interact with atmospheric oxygen to yield the hydroperoxide anion (12), [7] which, in turn, isomerized into the final oxidation product (10). These assumptions appear to be supported by the following observation: anion (11) was formed directly from 3a by a slight excess of sodium hydride in N,N-dimethylformamide, and was in turn alkylated to compound (13) with n-butyl iodide; furthermore, 11 appeared to be stable for an hour at room temperature under inert atmosphere, while in an hour it was completely transformed into 10 by atmospheric oxygen. No attempt was made to isolate the postulated hydroperoxide intermediate; thus, further investigation is required to better elucidate the autoxidation pathway. In order to improve both the efficiency and the versatility of the synthesis of compound (3a), we tried to apply Danishefsky's approach [8] to the synthesis of pyrrolo[3,4-b]quinoline nucleus, which appears to be simplier and more versatile (Scheme 3).

Scheme 3



Reagents: **a**, MeONa/MeOH; **b**, $POCl_3$/EtOH; **c**, NBS-$(PhCOO)_2$/CCl_4; **d**, R-NH_2-K_2CO_3/EtOH; **e**, HCl/H_2O/EtOH.

Friedländer condensation (base-catalyzed) between 2-aminobenzophenone (14) and 2-oxobutyric acid (15) gave the expected carboxylic acid (16) which was characterized by ^{1}H-nmr spectroscopy only and readily converted into ethyl ester (17). Bromination of 17 with N-bromosuccinimide in presence of dibenzoyl peroxide yielded the γ-bromo ester (18) which was easily transformed into γ-lactam (3a-c). By refluxing 18 in ethanolic aqueous hydrochloric acid, lacton (7) was obtained in good yield, confirming the structure assumed for this compound.

EXPERIMENTAL

Melting points were determined in open capillaries on a Büchi 510 apparatus and are uncorrected. Microanalyses were carried out on a Perkin-Elmer 240C Elemental Analyzer. Merck silica gel 60, 70-230 mesh, was used for column chromatography and Riedel-de Haen DC-Mikrokarten SI F 37341 were used as tlc. Ir spectra were recorded in nujol mulls with a Perkin-Elmer mod. 397 spectrophotometer. ^{1}H-Nmr spectra were recorded with a Bruker AC 200 spectrometer in the indicated solvents (TMS as internal standard): the values of chemical shifts are expressed in ppm and coupling costants (J) in Hz. Mass spectra (EI, 70 eV) were recorded on a VG 70-250S spectrometer. Ir, nmr spectra and elemental analyses were performed by Dipartimento Farmaco Chimico Tecnologico - Università di Siena. Mass spectra were performed by Centro di Analisi e Determinazioni Strutturali - Università di Siena.

9-Phenylfuro[3,4-b]quinolin-1(3H)-one (5)

A mixture of 4 [4] (2.0 g, 6.14 mmol) in ethanol (20 ml) with 3N hydrochloric acid (20 ml) was refluxed for 96 h, then the organic solvent was removed in vacuo and the residue was diluted with water, made alkaline with solid sodium carbonate and extracted with chloroform. The organic layer was dried over sodium sulphate and evaporated in vacuo and the residue was purified by column cromatography eluting with dichloromethane -ethyl acetate (9:1) giving pure 5 as white solid (1.35 g, 84%), mp 203-204°C (lit.,[5] mp 204-205°C).

2,3-bis(Hydroxymethyl)-4-phenylquinoline (6)

To a suspension of lithium aluminium hydride (0.6 g, 15.8 mmol), in tetrahydrofuran (20 ml), a solution of 5 (1 g, 3.83 mmol) in tetrahydrofuran (40 ml) was added at 0°C under stirring. After 30 min at room temperature the hydride was hydrolyzed by addition of water and the inorganic material was filtered off. The filtrate was washed with brine, dried over sodium sulphate and evaporated. The residue was dissolved in ethanol (40 ml), 10% palladium on carbon (0.5 g) was added and the resulting mixture was stirred at room temperature overnight. The catalyst was removed by filtration, washed with hot ethanol and the filtrate was evaporated in vacuo. By washing the residue with petroleum ether-ethyl acetate, pure 6 (0.73 g, 72%) was obtained as colorless crystals. An analytical sample crystallized from ethyl acetate melted at 175-177°C. ^{1}H-Nmr (DMSO-d_6): 4.46 (d, J=5.0, 2H, CH_2), 4.99-5.05 (m, 3H, CH_2+OH), 5.34 (t, J=5.6, 1H, OH), 7.33-7.65 (m, 7H, Ar-H), 7.73-7.82 (m, 1H, Ar-H), 8.10 (d, J=8.2, 1H, Ar-H). Anal. Calcd for $C_{17}H_{15}NO_2$: C, 76.96; H, 5.70; N, 5.28. Found: C, 77.01; H, 5.87, N, 5.27.

9-Phenylfuro[3,4-b]quinolin-3(1H)-one (7)

Method A (from 6)

To a solution of 6 (0.6 g, 2.26 mmol) in chloroform (80 ml), activated manganese dioxide (6 g, 69 mmol) was added and the resulting mixture was stirred at room temperature for 1 h. The inorganic material was separated by filtration through Celite and washed with chloroform. The filtrate was evaporated to give 0.51 g of pure 7 as white solid (mp 190-192°C, 86%).

Method B (from 18)

A mixture of 18 (0.43 g, 1.16 mmol) in ethanol with 3N hydrochloric acid (10 ml) was refluxed for 19 h and then the organic solvent was removed in vacuo. The residue was diluted with water, basified with solid sodium carbonate and extracted with chloroform. The organic layer was washed with water, dried over sodium sulphate and evaporated in vacuo. By washing the residue with ethanol and then with petroleum ether, pure 7 was obtained (0.16 g, 53%, mp 189-192°C). An analytical sample crystallized from ethanol melted at 191-192°C. Ir: 1770 cm^{-1}. ^{1}H-Nmr ($CDCl_3$): 5.41 (s, 2H, CH_2), 7.43-7.48 (m, 2H, Ar-H), 7.58-7.71 (m, 4H, Ar-H), 7.83-7.94 (m, 2H,Ar-H), 8.47 (d, J=8.6, 1H, Ar-H). Ms: m/z 261 (M^+, 95) Anal. Calcd for $C_{17}H_{11}NO_2$: C, 78.14; H, 4.24; N, 5.36. Found: C, 78.37; H, 4.31, N, 5.32.

N-Benzyl-3-hydroxymethyl-4-phenylquinoline-2-carboxamide (8)

A mixture of 7 (0.5 g, 1.91 mmol) in ethanol (30 ml) and 1.26 ml (11.5 mmol) of benzylamine was refluxed overnight and then the volatile fraction was distilled. The residue was quickly purified by column chromatography eluting with dichloromethane-ethyl acetate (8:2) and 8 was obtained as colorless crystals (0.57 g, 81%). An analytical sample crystallized from cyclohexane-benzene melted at 156-157°C. Ir: 3450, 3400, 1660 cm^{-1}. ^{1}H-Nmr ($CDCl_3$): 4.70 (d, J=7.5, 2H, CH_2-OH), 4.76 (d, J=6.2, 2H, CH_2-NH), 5.26 (t, J=7.5, 1H, OH), 7.28-7.59 (m, 12H, Ar-H), 7.66-7.75 (m, 1H, Ar-H), 8.08 (d, J=8.8, 1H, Ar-H), 8.82 (br s, 1H, NH). Ms: m/z 368 (M^+, 7). Anal. Calcd for $C_{24}H_{20}N_2O_2$: C, 78.24; H, 5.47; N, 7.60. Found: C, 78.52; H, 5.52, N, 7.84.

N-Benzyl-3-chloromethyl-4-phenylquinoline-2-carboxamide (9)

To a solution of 8 (0.46 g, 1.25 mmol) in dichloromethane (20 ml) thionyl chloride (2 ml, 27.57 mmol) was added and the resulting mixture was stirred at room temperature fo 5 h. The solvent was evaporated in vacuo and the thionyl chloride excess was removed by azeotropic distillation with toluene; thus 9 was obtained as colorless crystals (0.47 g, 97%, mp 153-154°C). Recrystallization from cyclohexane gave an analytical sample melting at 154-155°C. Ir: 3350, 1660 cm^{-1}. ^{1}H-Nmr ($CDCl_3$): 4.77 (d, J=5.9, 2H, CH_2-NH), 5.24 (s, 2H, CH_2Cl), 7.30-7.62 (m, 12H, Ar-H), 7.71-7.79 (m, 1H, Ar-H), 8.17 (d, J=8.4, 1H, Ar-H), 8.52 (br s, 1H, NH). Ms: m/z 386 (M^+, 22). Anal. Calcd for $C_{24}H_{19}N_2OCl$: C, 74.51; H, 4.95; N, 7.24. Found: C, 74.75; H, 5.00, N, 7.38.

2-Benzyl-2,3-dihydro-9-phenyl-1H-pyrrolo[3,4-b]quinolin-3-one (3a)

Method A (from 9)

To a solution of 9 (0.10 g, 0.26 mmol) in dry N,N-dimethylformamide (5 ml), 97% sodium hydride (0.019 g, 0.79 mmol) was added and the resulting mixture was stirred at 0°C for 10 min. Then the reaction mixture was poured into ice-water, 3N hydrochloric acid was added up to neutrality and the gummy precipitate was extracted with dichloromethane. The extracts were washed with water, dried over sodium sulphate and evaporated in vacuo to give colorless crystals of pure 3a (0.08 g, 88%, mp 226-227°C).

Method B (from 18)

A mixture of 18 (0.97 g, 2.62 mmol) in ethanol (30 ml) and benzylamine (0.58 ml, 5.3 mmol) in presence of potassium carbonate (1.0 g, 7.2 mmol) was refluxed for 1 h and then the solvent was removed in vacuo. The residue was partitioned between dichloromethane and water and the organic layer was then washed with water, dried over sodium sulphate and concentrated in vacuo. By washing the residue with ethyl acetate pure 3a was obtained as a white powder (0.76 g, 83%), mp 228-229°C (lit.,[3] mp 329-330°C).

2-(4-Chlorobenzyl)-2,3-dihydro-9-phenyl-1H-pyrrolo[3,4-b]quinolin-3-one (3b)

This compound was prepared from 18 by methodology B described for compound (3a) using 4-chlorobenzylamine instead of benzylamine; 3b was recrystallized from ethyl acetate to obtain an analytical sample melting at 174-175°C (82%). Ir: 1700 cm^{-1}. ^{1}H-Nmr ($CDCl_3$): 4.25 (s, 2H, CH_2 pyrrole), 4.89 (s, 2H, CH_2-Ph), 7.25-7.45 (m, 6H, Ar-H), 7.51-7.63 (m, 4H, Ar-H), 7.78-7.86 (m, 2H, Ar-H), 8.49 (d, J=8.5, 1H, Ar-H). Anal. Calcd for $C_{24}H_{17}N_2OCl$: C, 74.90; H, 4.45; N, 7.28. Found: C, 75.12; H, 4.44, N, 7.29.

(±)2-(sec-Butyl)-2,3-dihydro-9-phenyl-1H-pyrrolo[3,4-b]quinolin-3-one (3c)

This compound was prepared from 18 by methodology B described for compound (3a) using sec-butylamine instead of benzylamine; 3c was recrystallized from cyclohexane-ethyl acetate to give an analytical sample melting at 229-230°C (78%). Ir: 1700 cm^{-1}. ^{1}H-Nmr ($CDCl_3$): 0.91 (t, J=7.4, 3H, CH_3-CH_2), 1.28 (d, J=6.7, 3H, CH_3-CH), 1.56-1.71 (m, 2H, CH_2), 4.25 (ABq, J=16.7, 2H, CH_2 pyrrole), 4.54-4.72(m, 1H, CH), 7.43-7.62 (m, 6H, Ar-H), 7.74-7.82 (m, 2H, Ar-H), 8.46 (d, J=8.4, 1H, Ar-H). Ms: m/z 316 (M^+, 58). Anal. Calcd for $C_{21}H_{20}N_2O$: C, 79.72; H, 6.37; N, 8.86. Found: C, 79.58; H, 6.44, N, 8.67.

2-Ethoxycarbonyl-3-methyl-4-phenylquinoline (17)

To a solution of 2-aminobenzophenone (14) (5.9 g, 30 mmol) in dry methanol (150 ml) with 2-oxobutyric acid (15) (3.37 g, 33 mmol), a 30% solution of sodium methoxide (10 ml, 53.87 mmol) was added and the resulting mixture was refluxed for 72 h. After removal of the solvent in vacuo the residue was partitioned between ether-tetrahydrofuran and water; the organic layer was discarded, while the aqueous solution was acidified with acetic acid and extracted with ethyl acetate. The extracts were dried over sodium sulphate and evaporated to dryness in vacuo to obtain a thick oil which crystallized on standing. By washing with ether pure 16 was obtained (3.6 g, 13.67 mmol), dissolved in dry ethanol (100 ml) and phosphorus oxychloride (5 ml, 546.3 mmol) was added. The resulting mixture was kept to reflux for 24 h and then the solvent was evaporated in vacuo, the residue was diluted with water, basified by addition of solid sodium carbonate and finally extracted with dichloromethane.

The extracts were washed with water, dried over sodium sulphate and evaporated in vacuo to give 17 (3.5 g, 40%) as colorless crystals. An analytical sample recrystallized from n-hexane melted at 114-115°C. Ir: 1720 cm^{-1}. ^{1}H-Nmr ($CDCl_3$): 1.51 (t, J=7.0, 3H, CH_3-CH_2), 2.35 (s, 3H, CH_3), 4.60 (q, J=7.0, 2H, CH_2-CH_3), 7.24-7.61 (m, 7H, Ar-H), 7.71-7.79 (m, 1H, Ar-H), 8.48 (d, J=8.4, 1H, Ar-H). Anal. Calcd for $C_{19}H_{17}NO_2$: C, 78.33; H, 5.88; N, 4.81. Found: C, 78.62; H, 6.00, N, 4.83.

3-Bromomethyl-2-ethoxycarbonyl-4-phenylquinoline (18)

A mixture of 17 (1.1 g, 3.78 mmol) in carbon tetrachloride (50 ml) with N-bromosuccinimide (0.66 g, 3.71 mmol) and dibenzoyl peroxide (0.1 g, 0.4 mmol) was refluxed for 7 h; the solvent was then evaporated in vacuo and the residue was diluted with a small portion of the same solvent and filtered. The filtrate was concentrated in vacuo and the residue was purified by column chromatography eluting with dichloromethane. Thus pure 18 was obtained as colorless crystals (1.0 g, 70%). Recrystallization from n-hexane gave an analytical sample melting at 130-131°C. Ir: 1720 cm^{-1}. ^{1}H-Nmr ($CDCl_3$): 1.52 (t, J=7.0, 3H, CH_3-CH_2), 4.61 (q, J=7.0, 2H, CH_2-CH_3), 4.77 (s, 2H, CH_2Br), 7.35-7.58 (m, 7H, Ar-H), 7.71-7.79 (m, 1H, Ar-H), 8.24 (d, J=8.4, 1H, Ar-H). Anal. Calcd for $C_{19}H_{16}NO_2Br$: C, 61.63; H, 4.36; N, 3.78. Found: C, 61.87; H, 4.30, N, 3.70.

N-Benzyl-3-carboxy-4-phenylquinoline-2-carboxamide (10)

Method A (from 9)

To a solution of 9 (0.1 g, 0.26 mmol) in dry N,N-dimethylformamide (5 ml), 97% sodium hydride (0.019 g, 0.79 mmol) was added. The resulting mixture was stirred at room temperature for 60 min and poured into ice-water, acidified with 3N hydrochloric acid and extracted with dichloromethane. The organic layer was washed with water, dried over sodium sulphate and evaporated to give a pale yellow oil which crystallized by treatment with benzene. The colorless crystals were collected by filtration and dried to give pure 10 (0.05 g, 50%).

Method B (from 3a)

To a solution of 3a (0.1 g, 0.29 mmol) in dry N,N-dimethylformamide (5 ml), 97% sodium hydride (0.014 g, 0.58 mmol) was added and the resulting mixture was stirred at room temperature for 1 h. Then the reaction mixture was poured into ice-water, acidified with 3N hydrochloric acid and extracted with dichloromethane. The extracts were washed with water, dried and concentrated in vacuo to give a pale-yellow oil which crystallized on treatment with benzene. After filtration g 0.06 (54%) of pure 10 were obtained as colorless needles. An analytical sample recrystallized from benzene melted at 181-182°C. Ir: 3410, 3180, 1730, 1680 cm^{-1}. ^{1}H-Nmr (DMSO-d_6): 4.58 (d, J=6.2, 2H, CH_2-NH), 7.25-7.64 (m, 11H, Ar-H), 7.66-7.75 (m, 1H, Ar-H), 7.90-7.98 (m, 1H, Ar-H), 8.24 (d, J=8.4, 1H, Ar-H), 9.53 (t, J=6.2, 1H, NH), 12.84 (br s, 1H, COOH). Anal. Calcd for $C_{24}H_{18}N_2O_3$: C, 75.38; H, 4.75; N, 7.33. Found: C, 75.63; H, 4.95, N, 7.29.

2-Benzyl-1-butyl-2,3-dihydro-9-phenyl-1H-pyrrolo[3,4-b]quinolin-3-one (13)

A mixture of 3a (0.1 g, 0.29 mmol) in dry N,N-dimethylformamide (5 ml) with 97% sodium hydride (0.014 g, 0.58 mmol) was stirred at room temperature under a nitrogen atmosphere for 10 min, then a solution of n-butyl iodide (0.033 ml, 0.29 mmol) in dry N,N-dimethylformamide (2 ml) was added and the resulting mixture was stirred at room temperature for 4 h under a nitrogen atmosphere. After pouring into ice-water the reaction mixture

was neutralized by 3N hydrochloric acid and extracted with dichloromethane. The organic layer was washed with water, dried over magnesium sulphate and evaporated in vacuo. The residue was purified by column chromatography, eluting with n-hexane-ethyl acetate (6:4) to give pure 13 as colorless oil which solidified on treatment with n-hexane-ethyl acetate (0.07 g, 59%). An analytical sample recrystallized from n-hexane-ethyl acetate melted at 129-130°C. Ir: 1700 cm^{-1}. ^{1}H-Nmr ($CDCl_3$): 0.27-0.51 (m, 1H), 0.59 (t, J=7.0, 3H, CH_3), 0.69-1.20 (m, 4H), 1.59-1.78 (m, 1H), 4.22 (d, J=15.0, 1H, CH-Ph), 4.71 (t, J=3.0, 1H, CH pyrrole), 5.50 (d, J=15.0, 1H, CH-Ph), 7.27-7.36 (m, 7H, Ar-H), 7.49-7.61 (m, 4H, Ar-H), 7.71-7.86 (m, 2H, Ar-H), 8.53 (d, J=8.4, 1H, Ar-H). Anal. Calcd for $C_{28}H_{26}N_2O$: C, 82.73; H, 6.45; N, 6.89. Found: C, 82.87; H, 6.63, N, 7.02.

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REFERENCES

1. M. Anzini, A. Cappelli, S. Vomero, A. Cagnotto,and M. Skorupska, Il Farmaco, 1992, 47, 191.
2. M. C. Dubroeucq, C. Renault, and G. Le Fur, Fr. Demande FR 2,525,595, 1982, (Chem.Abstr., 100, 138972h).
3. R. Madhav and P. L. Southwick, J. Heterocycl. Chem., 1972, 9, 443.
4. M. Anzini, S. Vomero, A. Garofalo, A. Cappelli,and A. Cagnotto, Il Farmaco, 1989, 44, 555.
5. a) D. G. Schmidt, P. D. Seemuth, and H. Zimmer, J. Org. Chem., 1983, 48, 1914.
   b) E. A. Fehnel, J. A. Deyrup,and M. B. Davidson, J. Org. Chem., 1958, 23, 1996.
6. S. Danishefsky, T. A. Bryson,and J. Puthenpurayil, J. Org. Chem., 1975, 40, 1846.
7. H. R. Gersmann and A. F. Bickel, J. Chem. Soc. (B), 1971, 2231.
8. S. Danishefsky, T. A. Bryson,and J. Puthenpurayil, J. Org. Chem., 1975, 40, 796.

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