SYNTHESES OF INDOLYL-4(3*H*)-QUINAZOLINONES#

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Abstract — 2-(1*H*-Indol-2-yl)-4(3*H*)-quinazolinones (**10, 11**) and 2-(2-ethoxycarbonyl-1*H*-indol-3-yl)-4(3*H*)-quinazolin-4-one (**15**) are prepared by the Fischer indolization of 2-(1-phenylhydrazonoalkyl)- (**8, 9**) and 2-(2-phenylhydrazono-2-ethoxycarbonylethyl)-4(3*H*)-quinazolinones (**14**), respectively, by heating in PPA. When 2-phenylhydrazone derivative (**14**) is heated in 85% phosphoric acid at 180°C, besides indolization ester hydrolysis and decarboxylation also occurred to yield 2-(1*H*-indol-3-yl)-4(3*H*)-quinazolinone (**16**). The 3-(1*H*-indol-3-yl)-4(3*H*)-quinazolinone (**24**) is prepared either from the isomeric 3-indolyl derivatives of anthranilamide (**21, 23**) by heating in 98% formic acid, or in "one pot" procedure from 2-[1-(*N*-methyl-*N*-phenylamino)ethyl]-4(3*H*)-quinazolinone (**17**) by heating in 98% formic acid in the presence of a few drops of conc. hydrochloric acid. The reaction mechanism is discussed.

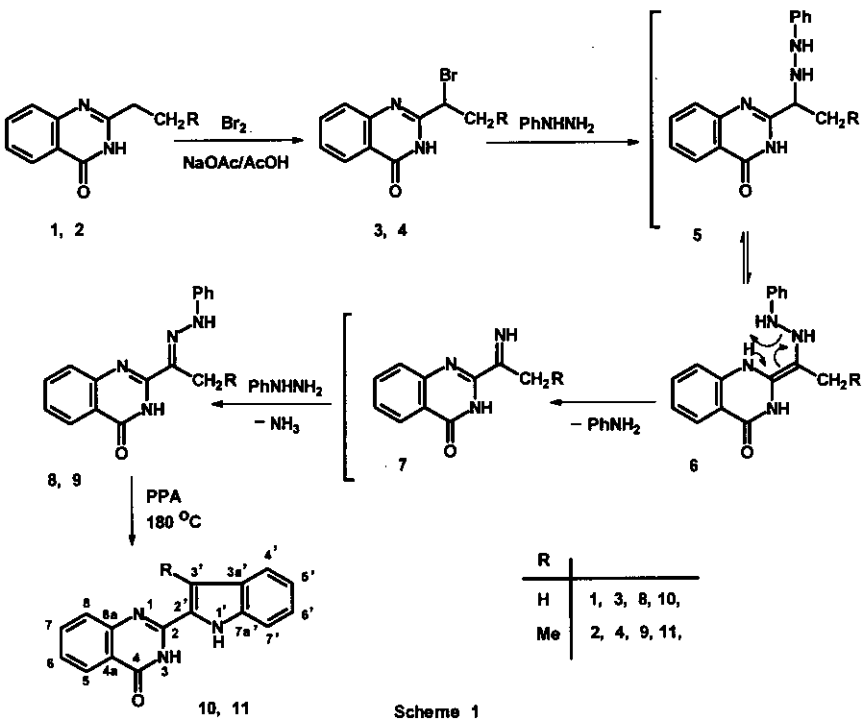
Because of the great practical importance of quinazoline[1-3] and indole[4-6] derivatives as alkaloids[1,4] and biologically active compounds[2,5] their chemistry are fundamentally interesting to heterocyclic chemists.[3,6] However, only a few derivatives are known, in which indole and quinazoline rings are connected directly by a bond,[7-10] or *via* a chain[11-26] between positions 2′ and 2;[7,8] 3′ and 2;[11,12] 3′ and 3;[13-26] or 3′ and 4.[9,10] These

Dedicated with much admiration to Prof. Alan R. Katritzky on the occasion of his 65th birthday.

derivatives are useful intermediates for the syntheses of rutaecarpine,[13-19] or its derivatives,[20] and tryptoquivaline[21] alkaloids, and exhibit antiinflammatory,[10] neuroprotective,[10] antihypertensive,[22] anticonvulsant[25] activities, furthermore serotonin[23,24] and cholecystokinin[12] antagonistic properties.

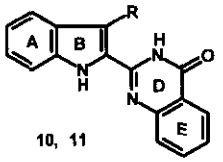
Now we describe syntheses of indolyl-4(3*H*)-quinazolinones connected in different positions, by the rearrangements of 2-substituted alkyl-4(3*H*)-quinazolinones.

Synthesis of 2-(2-Indolyl)-4(3*H*)-quinazolinones (10, 11). The reaction of 2-alkyl-4(3*H*)-quinazolinones (**1, 2**) with mole equiv. of bromine in acetic acid in the presence of sodium acetate at 60°C for 3-4 h afforded 2-(1-bromoalkyl) derivatives (**3, 4**). When bromo derivatives (**3, 4**) were reacted with 3 mole equiv. of phenylhydrazine in ethanol at reflux temperature for 8-10 h 2-(1-phenylhydrazonoalkyl)quinazolinones (**8, 9**) were obtained in 58-67% yields. The hydrazono moiety was probably formed in an osazone-like reaction, since similar mechanism was observed in the reaction of 9-bromo-6,7,8,9-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidin-4-ones and hydrazines.[27]

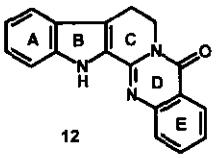


Scheme 1

During this process, in the first step a substitution reaction gave rise 2-(1-phenylhydrazinoalkyl)quinazolinone intermediates (**5**), from their tautomeric form (**6**) aniline was eliminated to yield 2-(1-iminoalkyl)quinazolinones (**7**). In the next step 2-(1-iminoalkyl)quinazolinones (**7**) reacted with a second mol of phenylhydrazine to



10, 11



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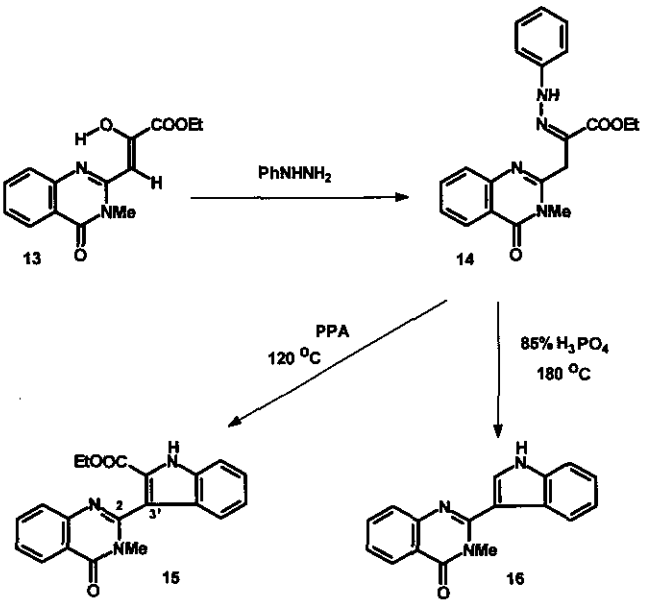
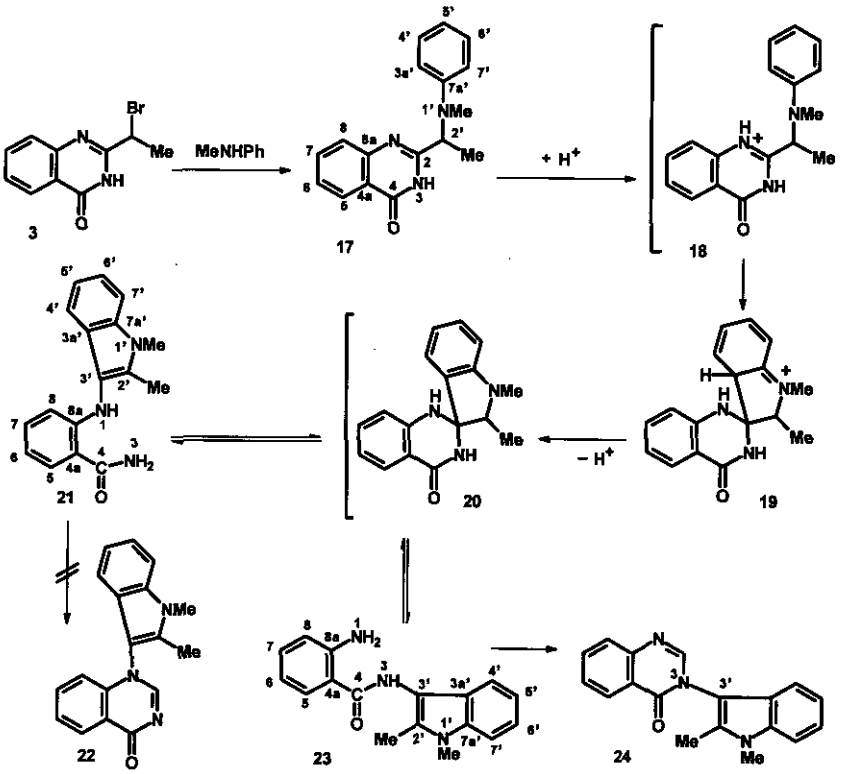
afford 2-(1-phenylhydrazonoalkyl) derivatives (**8, 9**) as it is depicted on Scheme 1. The phenylhydrazono derivatives (**8, 9**) exist predominantly as *E* geometric isomers in DMSO-d_6. In a NOE experiment irradiation of NH proton of compound (**8**) resulted in 10 % intensity enhancement of Me signal; and irradiation of protons of Me group resulted in 6 % intensity enhancement of NH signal. The heating of phenylhydrazones (**8, 9**) in polyphosphoric acid at 180°C for 30 min gave 2-(2-indolyl)quinazolinones (**10, 11**) in good yield. Compounds (**10, 11**) can be considered as the ring opened analogues of rutaecarpine alkaloid (**12**). Compound (**10**) was previously prepared[8] by Bergman and Eklund in 75% yield in the reaction of indole-2-carboxylic acid, trifluoroacetic anhydride and anthranilamide in pyridine.

Synthesis of 2-(3-Indolyl)-4(3*H*)-quinazolinones (15, 16). Reaction of quinazolinone (**13**) with phenylhydrazine in dimethylformamide at 100°C for 6 h gave 2-(2-phenylhydrazono-2-ethoxycarbonylethyl)-4(3*H*)-quinazoline (**14**). The Fischer indolization of phenylhydrazone (**14**) in polyphosphoric acid at 120°C for 15 min afforded 2-(2-ethoxycarbonyl-3-indolyl)-4(3*H*)quinazolinone (**15**) in 47% yield. When phenylhydrazone (**14**) was heated in 85% phosphoric acid at 180°C for 1 h, besides indolization ester hydrolysis and decarboxylation also occurred to give 2-(3-indolyl)-4(3*H*)-quinazolinone (**16**).



Scheme 2

Synthesis of 3-(3-Indolyl)-4(3*H*)-quinazolinone (24). Reaction of 2-(1-bromoethyl)-4(3*H*)-quinazolinone (**3**) and *N*-methylaniline in dimethylformamide at 60°C for 6 h under nitrogen gave 2-[1-(*N*-methyl-*N*-phenylamino)ethyl]-4(3*H*)-quinazolinone (**17**) in 64.5% yield. When the reaction mixture was heated at 100°C for 10 h, then a 6:4 mixture of isomeric 3-indolyl derivatives of anthranilamide (**21, 23**) was obtained in 83% yield. The isomeric indole derivatives (**21, 23**) could be separated by fractional crystallization from ethanol. Full assignment of the ^{1}H and ^{13}C nmr spectra of **21** and **23** was based on 2D homo and heteronuclear chemical shift correlation experiments (COSY, HETCORR, HMBC). The two isomers (**21** and **23**) were unambigously identified by NOE experiments (Table 5).



Scheme 3

The isomeric anthranilamide (**21**) and (**23**) formed from the spiro compound (**20**) by ring opening of quinazolinone ring along N(1)-C(2) and C(2)-N(3) bond, respectively. We assumed that the first step of the formation of the spiro intermediate (**20**) was the protonation of 2-[1-(*N*-methyl-*N*-phenylamino)ethyl]quinazolinone (**17**) at N(1) atom. This was formally followed by the addition of the phenyl ring of anilino moiety into

N(1)-C(2) double bond. The deprotonation of the formed **19** resulted in the formation of the spiro intermediate (**20**).

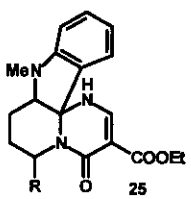
Similar reaction was previously observed between 9-bromo-6,7,8,9-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidin-4-ones and *N*-methylaniline,[28] but in these cases tetracyclic indole derivatives (**25**) could be isolated.

Table 1. Uv data on **10**, **11**, **17**, **21**, **23** and **24** in Ethanol

Compound No	λ_{max} (ε)						
10	354i(23500)	340 (32300)	330i(30400)	286i(7800)	274i(6200)	234i(23840)	224 (27800) 212 (31400)
11	362i(15000)	342i(24800)	332 (25500)	266i(5500)	238i(24800)	231 (25800)	215 (26000)
17	312i(2400)	302 (4280)	294i(4000)	270i(8000)	245i(7650)	230i(26500)	224 (27500)
21	346 (4200)	290i(6300)	280i(7200)	258 (11000)	224 (32100)		
23	325 (5300)	290 (8700)	282 (8900)	250i(10220)	220 (45190)		
24	310i(53620)	288i(11200)	274 (15200)	266i(14800)	224 (56800)		

i = inflexion

The heating of *N*-(1,2-dimethyl-1*H*-indol-3-yl)-2-aminobenzamide (**23**) in 98% formic acid at 110°C for 4 h afforded 3-(1,2-dimethyl-3-indolyl)-4(3*H*)-quinazolinone (**24**) in 78% yield. When the isomeric 2-aminobenzamide (**21**) was heated in 98% formic acid at reflux temperature for 14 h, instead of the expected isomeric 1-(1,2-dimethyl-3-indolyl)-4(1*H*)-quinazolinone (**22**), the 3-(3-indolyl)-4(3*H*)-quinazolinone (**24**) was obtained in 40.5% yield. In this case the isomerization of compound (**21**) into **23** occurred *via* the spiro compound (**20**) in the first step. Then this was followed by the reaction of formic acid to yield 3-(3-indolyl)-quinazolinone (**24**). The latter compound can be also prepared in "one pot" procedure in 79.6% yield from 2-[1-(*N*-methyl-*N*-phenylamino)ethyl]-4-(3*H*)-quinazolinone (**17**) by heating in 98% formic acid at reflux temperature for 4 h in the presence of a few drops of conc. hydrochloric acid. No formation of compound (**24**) occurred in the absence of conc.hydrochloric acid.



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Thanks due to Dr Levente Pusztay for recording and interpreting the uv and ir spectra.

EXPERIMENTAL

All melting points are uncorrected and yields were not maximized. The uv spectra were recorded in ethanolic solution with an Zeiss Specord M 80 spectrophotometer, ir spectra in potassium bromide pellets with Zeiss

Table 2. Characteristic bands in the ir spectra of **10**, **11**, **15-17**, **21**, **23** and **24** in KBr

Compound	υNH	$\upsilon CH_{Aromatic}$	$\upsilon CH_{Aliphatic}$	υC=O	Aromatic skeletal vibrations
10	3170	3120, 3080, 3020	2940	1690	1600, 1580, 1540, 1500
11	3350	3040	2950, 2910	1670	1600, 1550, 1500
15	3125	-	-	1725, 1666	1610
16	3230	-	-	1676	
17	3180	3120, 3040	2960, 2920, 2880	1670	1600, 1580, 1500
21	3460, 3350	3030	2900	1650	1600, 1580, 1500
23	3480, 3380, 3180	3080, 3020	2980, 2920	1630	1600, 1580, 1550, 1500
24		3060	2960, 2920	1680	1600, 1550, 1490

Specord M80 spectrophotometer, ^1H and ^{13}C nmr spectra using TMS as the internal standard with a Bruker AC-400/P spectrometer at 400.132 MHz and 100.614 MHz, respectively.

Bromination of 2-Alkyl-4(3*H*)-quinazolinones. — To a solution of 2-alkyl-4(3*H*)-quinazolinone[29] (**1**, **2**) (10 mmol) and sodium acetate (8.2 g, 10 mmol) in acetic acid (120 ml) a solution of bromine (16.0 g, 10 mmol) in acetic acid (40 ml) was dropwise added at 60°C. The reaction mixture was stirred while the colour of bromine disappeared (*ca.* 3 h). Then the reaction mixture was gradually poured into cold water. The precipitated crystals were filtered off, washed with water; dried to give 2-(1-bromoalkyl) derivatives (**3**, **4**).

2-(1-Bromoethyl)-4(3*H*)-quinazolinone (**3**) was obtained in 78.6% yield from **1**;[29] mp 254-255°C. Anal. Calcd for $C_{10}H_9N_2OBr$: C, 47.45; H, 3.58; N, 11.07; Br, 31.57. Found: C, 47.72; H, 3.49; N, 10.93; Br, 31.79.

2-(1-Bromopropyl)-4(3*H*)-quinazolinone (**4**) was obtained in 78.7% yield from **2**;[29] mp 215-217°C. Anal.

Table 3. ^1H Nmr chemical shifts of **10**, **11**, **15-17**, **21**, **23 and 24**

Compound	**10** DMSO-d_6	**11** DMSO-d_6	**15**[a] $CDCl_3$	**16**[a] $CDCl_3$	**17** DMSO-d_6	**21** Acetone-d_6	**23** Acetone-d_6	**24** DMSO-d_6
1-H	-	-	-	-	-	9.62	6.24[b]	-
2-H	-	-	-	-	-	-	-	8.27
3-H	11.83	11.46	-	-	12.9	7.45; 6.6	8.83	-
5-H	8.18	8.16	8.28	8.32	8.10	7.72	7.84	8.24
6-H	7.49	7.50	6.90-8.00	7.00-8.00	7.50	6.56	6.61	7.61
7-H	7.83	7.83	6.90-8.00	7.00-8.00	7.79	7.10	7.19	7.89
8-H	7.75	7.72	6.90-8.00	7.00-8.00	7.66	6.43	6.62	7.78
1'-H	12.5	11.99	10.86	9.94	-	-	-	-
2'-H	-	-	-	6.28	4.98	-	-	-
3'-H	7.71	-	-	-	-	-	-	-
3'a-H	-	-	-	-	6.88	-	-	-
4'-H	7.65	7.65	6.90-8.00	7.00-8.00	7.19	7.22	7.41	7.23
5'-H	7.06	7.09	6.90-8.00	7.00-8.00	6.69	6.95	6.99	7.05
6'-H	7.24	7.26	6.90-8.00	7.00-8.00	7.19	7.10	7.09	7.20
7'-H	7.57	7.46	6.90-8.00	7.00-8.00	6.88	7.38	7.32	7.53
NCH_3	-	-	3.95	3.71	2.83	3.75	3.68	3.78
CCH_3	-	2.69	4.30[c], 1.31	-	1.47	2.31	2.31	2.30

a: at 80 MHz on an Bruker WP80 instrument; b: two proton intensity; c: the signal of $O\text{-}CH_2$ group

Table 4: ^{13}C Nmr chemical shifts of **10**, **11**, **17**, **21**, **23** and **24**

Compound	**10**	**11**	**17**	**21**	**23**	**24**
	DMSO-d_6	DMSO-d_6	DMSO-d_6	Acetone-d_6	Acetone-d_6	DMSO-d_6
C-2	146.8	147.8	157.7	-	-	148.8
C-4	162.1	161.8	161.9	173.0	169.4	160.2
C-4a	121.4	120.8	121.4	114.7	116.4	122.1
C-5	126.3	126.0	125.9	129.5	129.1	126.5
C-6	126.4	126.4	126.8	115.8	116.0	127.3
C-7	134.8	134.8	134.5	133.3	132.7	134.5
C-8	127.1	127.4	127.5	114.4	117.5	127.4
C-8a	148.9	149.2	148.5	151.9	151.1	147.9
C-2'	130.3	128.6	56.4	133.5	132.9	134.1
C-3'	105.2	115.8	-	114.4	111.1	110.2
C-3'a	127.7	126.0	113.9	129.5	125.9	123.7
C-4'	121.7	119.9	129.0	118.0	118.4	116.3
C-5'	120.2	119.6	117.4	119.7	119.5	119.9
C-6'	124.3	124.3	129.0	121.6	121.3	121.3
C-7'	112.6	112.0	113.9	109.9	109.6	109.7
C-7'a	137.9	136.3	149.5	136.6	136.2	135.0
NCH_3	-	-	33.2	29.9	29.7	29.7
CCH_3	-	10.5	14.0	9.6	10.2	9.4

Calcd for $C_{11}H_{11}N_2OBr$: C, 49.46; H, 4.15; N, 10.49; Br, 31.57. Found: C, 49.28; H, 4.21; N, 10.60; Br, 31.73.

2-(1-Phenylhydrazonoethyl)-4(3*H*)-quinazolinone (8). — A solution of **3** (2.52 g, 10 mmol) and phenylhydrazine (4.32 g, 40 mmol) in ethanol (80 ml) was refluxed for 10 h. After cooling the precipitated crystals were filtered off, washed with ethanol, dried and recrystallized from ethanol to give 1.86 g (66.9%) of **8,** mp 310-312°C. ^1H Nmr (DMSO-d_6):δ(ppm) 2.32 (3H, s, Me); 6.60-7.05 (1H, m, 5'-H); 7.15-8.00 (7H, m, 6-, 7-, 8-, 3a'-, 4'-, 6', 7'-H); 8.15 (1H, d, *J*=8.2 Hz, 5-H); 9.90 (1H, s, -NH-N=); 11.50 (1H, s 3-H), ^{13}C Nmr (DMSO-d_6); at 20.1 MHz; 10.6 (Me); 150.5 (C-2); 160.5 (C-4); 120.8 (C-4a); 127.4 (C-5); 126.4 (C-6); 134.4 (C-7); 126.0 (C-8); 148.7 (C-8a); 134.3 (2-C-Me); 114.3, 121.6, 128.8, and 144.4 (Ph). Anal. Calcd for $C_{16}H_{14}N_4O$: C, 69.05; H, 5.07; N, 20.13. Found: C, 68.84; H, 5.12; N, 20.22.

2-(1-Phenylhydrazonopropyl)-4(3*H*)-quinazolinone (9). — A solution of **4** (2.67 g, 10 mmol) and phenylhydrazine (4.32 g, 40 mmol) in ethanol (40 mol) was refluxed for 8 h. After cooling the precipitated crystals were filtered off, washed with ethanol, dried, and recrystallized from ethanol to give 1.7g (58.2%) of **9** mp 281-283°C. Anal Calcd for $C_{17}H_{16}N_4O$: C, 69.85; H, 5.52; N, 19.16. Found: C, 69.98; H, 5.42; N, 19.23.

2-(1*H*-Indol-2-yl)-4(3*H*)-quinazolinone (10). — Hydrazone (**8**) (1 g, 3.59 mmol) was stirred in PPA (Fluka) (5 ml) at 180°C for 30 min. The reaction mixture was poured into water (30 ml) and the precipitated crystals were filtered off, washed with ethanol, dried, and recrystallized from aqueous DMF to give 0.75 g (79.8%) of

10 mp 328°C (decomp.). lit.,[8] mp 318-320°C. Anal. Calcd for $C_{16}H_{11}N_3O$: C, 73.54; H, 4.25; N, 16.09. Found: C, 73,72; H, 4.13; N, 15.93.

2-(3-Methyl-1*H*-indol-2-yl)-4(3*H*)-quinazolinone (11). — Hydrazone (**9**) (1 g, 3.42 mmol) was stirred in PPA (Fluka) (8 g) at 180°C for 30 min. The reaction mixture was poured into water (40 ml), and the precipitated crystals were filtered off, washed with ethanol, dried and recrystallized from DMF to give 0.82 g (87.1%) of **11**, mp 316-319°C. Anal. Calcd for $C_{17}H_{13}N_3O$: C, 74.17; H, 4.76; N, 15.26. Found: C, 74.27; H, 4.81; N, 15.18.

Table 5: NOE intensity enhancements of **21**, **23** and **24** [%]

	Compounds		
Irradiated	**21**	**23**	**24**
5-H	6-H 6.0	N(3)H 9.0; 6-H 8.3	
8-H	N(1)-H 0.5; 7-H 5.5; CCH_3 0.2	N(1)-H_2 0.8; 7-H 3.8	
4'-H	N(1)-H 0.8; 5'-H 4.6	5'-H 6.0	
N-CH_3		7'-H 5.1; CCH_3 1.9	
C-CH_3	N(1)-H 1.6; 8-H 1.7; NCH_3 2.8	N(1)H_2 0.4; N(3)H 1.2; 5-H 0.2; NCH_3 2.5	2-H 4.5; N-CH_3 3

2-(2-Phenylhydrazono-2-ethoxycarbonylethyl)-4(3*H*)-quinazolinone (14). — A solution of **13**[30] (5.5 g, 20 mmol) and phenylhydrazine (1.6 g, 20 mmol) in DMF (50 ml) was heated at 100°C on a water-bath for 6 h. Then the reaction mixture was cooled to room temperature and it was diluted with water. The precipitated yellow crystals were filtered off, washed with water, dried and recrystallized from ethanol, to give 5.85 g (80%) of **14**, mp 186-189°C. Anal. Calcd for $C_{20}H_{20}N_4O_3$: C, 65.92; H, 5.53; N, 15.37. Found: C, 66.10; H, 5.48; N, 15.41.

2-(2-Ethoxycarbonyl-3-indolyl)-4(3*H*)-quinazolinones (15). — Into a preheated PPA (Fluka) (5 ml) to 120°C phenylhydrazone (**14**) (1 g, 2.74 mmol)) was gradually added, and the reaction mixture was intensively stirred at 120°C for 15 min. Then the reaction mixture was cooled to 10°C and it was diluted with water (40 ml). The precipitated crystals were filtered off, washed with water, and boiled in ethanol (10 ml) for 1 h, and then it was filtered. The ethanolic solution was gradually evaporated until crystal precipitation started. Then the ethanolic solution was cooled to room temperature, and stored in a refrigerator overnight. The crystals were filtered off, washed with ethanol, and dried. Compound (**15**) was obtained in 47% yield, (0.46 g), mp 236-240°C. Anal. Calcd for $C_{20}H_{17}N_3O_3$: C, 69.15; H, 4.93; N, 12.10. Found: C, 69.04; H, 4.99; N, 11.93.

2-(3-Indolyl)-4(3*H*)-quinazolinones (16). — Into a preheated 85% phosphoric acid (10 ml) to 180°C phenylhydrazone (**14**) (1 g, 2.74 mmol) was gradually added, and the reaction mixture was intensively stirred at 180°C

for 1 h. The reaction mixture was cooled to room temperature, and it was diluted with water (40 ml). The pH of the aqueous solution was adjusted to 7 with conc. ammonium hydroxide solution. The precipitated crystals were filtered off, washed with water. The dried crystals were boiled in chloroform (20 ml) for 1 h. The chloroformic solution was decolorized with active charcoal and filtered. The chloroformic solution was evaporated in vacuo to dryness. The residue was recrystallized from ethyl acetate to give **16** in 45% yield (0.34 g), mp 113-115°C. Anal. Calcd for: $C_{17}H_{13}N_3O$: C, 74.17; H, 4.76; N, 15.26. Found: C, 74.02; H, 4.88; N, 15.28.

2-[1-(*N*-Methyl-*N*-phenylamino)ethyl]-4(3*H*)-quinazolinone (17). — A solution of **3** (2.53 g, 10 mmol) and *N*-methylaniline (2.14 g, 20 mmol) in dimethylformamide (30 ml) was stirred at 60°C for 6 h under nitrogen. Then the reaction mixture was poured into water (150 ml) and the precipitated crystals were filtered off, washed with water, dried and recrystallized from ethanol to give 1.6 g (64.5%) of **17,** mp 182-185°C. Anal. Calcd for $C_{17}H_{17}N_3O$: C, 73.10; H, 6.13; N, 15.04. Found: C, 72.97; H, 6.15; N, 15.00.

Preparation of anthranilamides (21, 23). — When the above reaction mixture was heated for 10 h at 100°C, then a 6:4 mixture of anthranilamides (**21, 23**) (2.32 g, 83%) was obtained. Recrystallization of the mixture of **21** and **23** from ethanol gave pure **21** (0.64 g, 22.9%), mp 232-235°C. Anal. Calcd for $C_{17}H_{17}N_3O$: C, 73.10; H, 6.13; N, 15.04. Found: C, 73.21; H, 6.22; N, 74.93. From the ethanolic mother liquor **23** (0.72 g, 25.8%) was obtained after evaporation and recrystallization of the residue from ethanol (twice), mp 179-181°C. Anal. Calcd for $C_{17}H_{17}N_3O$: C, 73.10; H, 6.13; N, 15.04. Found: C, 73.28; H, 6.04; N, 15.12.

3-(1,2-Dimethyl-3-indolyl)-4(3*H*)-quinazolinone (24). From 21: — A solution of **21** (1 g, 3.58 mmol) in 98% formic acid (20 ml, 520 mmol) was boiled for 14 h. The dark reaction mixture was evaporated in vacuo to dryness. To the residue chloroform (25 ml) was added and the mixture was boiled for 1 h. The organic phase was decanted, and it was decolorized with active charcoal. The filtered chloroformic solution was washed with water (2 x 10 ml). The dried (Na_2SO_4) organic phase was evaporated in vacuo to dryness. The residue was crystallized from ethanol to give **24** (0.42 g, 40.5%), mp 248-250°C. Anal. Calcd for $C_{18}H_{15}N_3O$: C, 74.12; H, 5.23; N, 14.52. Found: C, 73.96; H, 5.33; N, 14.60.

From 23: A solution of **23** (1 g, 3.58 mmol) in 98% formic acid (10 ml, 260 mmol) was heated at 110°C for 4 h. The reaction mixture was evaporated in vacuo to dryness. The residue was dissolved in chloroform (25 ml). The chloroformic solution was washed with water (2 x 10 ml) and 5% aqueous sodium hydrogen carbonate.

The organic phase was decolorized with active charcoal, and the dried chloroformic solution was evaporated in vacuo to dryness. The residue was recrystallized from ethanol to give **24** (0.81 g, 78%), mp 250-251°C.

From 17: To a solution of **17** (1.39 g, 5 mmol) in 98% formic acid (10 ml, 260 mmol) one drop of conc. hydrochloric acid was added. The reaction mixture was refluxed for 4 h. Then the reaction mixture was evaporated in vacuo to dryness. The residue was dissolved in chloroform (20 ml). The organic phase was washed with 5% aqueous sodium hydrogen carbonate (2 x 10 ml) and water (2 x 10 ml). The dried (over Na_2SO_4) organic phase was evaporated in vacuo to dryness. The residue was recrystallized from ethanol to give **24** (1.15 g, 79.6%), which was identical with product obtained from **21** and **23**, respectively, mp 251-252°C.

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