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Syntheses of sulfoxide derivatives in the benzodiazine series. Diazines. Part 37

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Abstract—Syntheses of new sulfinylcinnolines, quinoxalines, quinazolines and phtalazines have been investigated starting from the appropriate halogenobenzodiazine derivatives. The latter were converted in one step to the corresponding sulfanyl benzodiazines which upon oxidation with *m*-CPBA led to the corresponding sulfoxide derivatives of benzodiazines in moderate to good yields. In parallel to this study, an improved method for the synthesis of 2-methylsulfinylquinoxaline starting from 2-sulfanylquinoxaline is also described and in the quinazoline series a synthetic route has been developed to prepare 2-*tert*-butyl-5-phenylsulfinylquinazoline with satisfactory yield as well as 2-*tert*-butyl-5-*tert*-butylsulfinyl-4(3*H*)-quinazolinone and 2-*tert*-butyl-8-*tert*-butylsulfinyl-4(3*H*)-quinazolinone.

1. Introduction

The benzodiazine skeleton is commonly found in compounds exhibiting a wide range of biological properties[1,2] such as inhibitor of tyrosine kinase,[3,4] antimalarial,[5] anticonvulsive,[6–9] antihypertensive,[10,11] hypolipidemic,[12] antitumoral,[13] and antiviral.[14] Usually construction of benzodiazines involves cyclization of appropriately substituted benzenes whose syntheses are not always easy. Indeed, the main synthetic route to cinnolines is the cyclization of *o*-substituted aryl hydrazones[15] or diazotation of *o*-substituted anilines.[16] Generally 2,3-substituted quinoxalines can be prepared by condensation of aryl-1,2-diamines and α-dicarbonyl compounds or their equivalents.[17–20] Frequently, quinazolines are synthesized starting from formamide and 2-aminobenzoic acid or their derivatives.[21] Alternatively, the fused phenyl ring may be assembled via a cycloaddition strategy.[22]

We had previously synthesized some diazine sulfoxides[23–25] and studied their metalation. We could highlight remarkable diastereoisomeric excesses by metalating chiral sulfoxides and using prochiral electrophiles such as aldehydes. As an extension of this topic, we have synthesized a number of sulfoxide derivatives in the benzodiazine series in order to study afterwards their metalation reactions with various substrates.

2. Results and discussion

In a previous paper,[26] we have reported the synthesis of 4-chlorocinnoline **1** by chlorination of the corresponding 4-hydroxycinnoline prepared in two steps from 2-iodoaniline.[27,28] It was converted to the sulfides **2a** and **2b** and then to the sulfoxides **3a** and **3b** by reaction with *m*-CPBA. A more vigorous oxidation of **2a** with potassium permanganate led to sulfone **4** (Scheme 1).

4-Chloro-6,7-dimethoxycinnoline[29–31] **5** (Table 1, entry 2) was synthesized from commercial 3,4-dimethoxyacetophenone. In contrast to the unstable character of 4-chlorocinnoline **1**, 4-chloro-6,7-dimethoxycinnoline **5** was completely stable at room temperature.

By analogy to the synthesis of 4-chlorocinnoline **1** described in our previous paper,[26] 4-chloro-3-*tert*-butylcinnoline **6** was obtained in good yield by an efficient Sonogashira cross-coupling reaction followed by diazotation (Scheme 2). The 4-hydroxy-3-*tert*-butylcinnoline **7**, obtained in the second step as by-product was converted smoothly by

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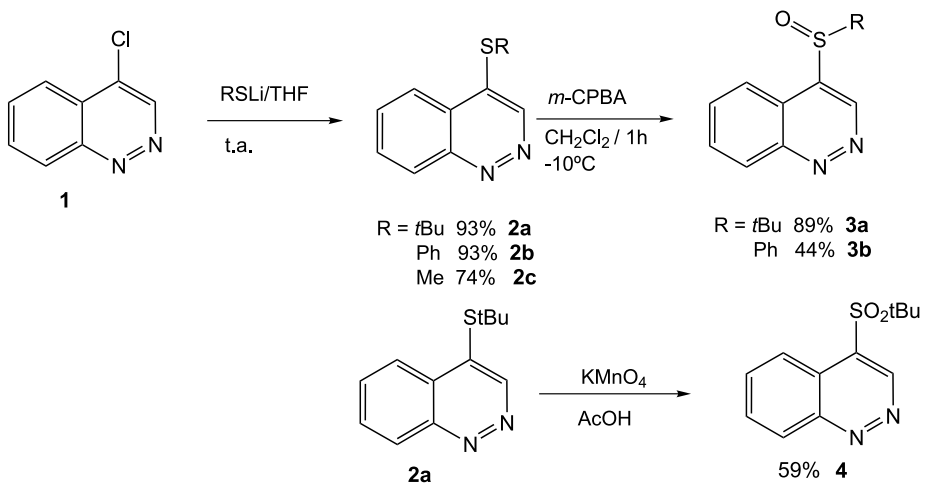
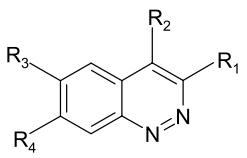
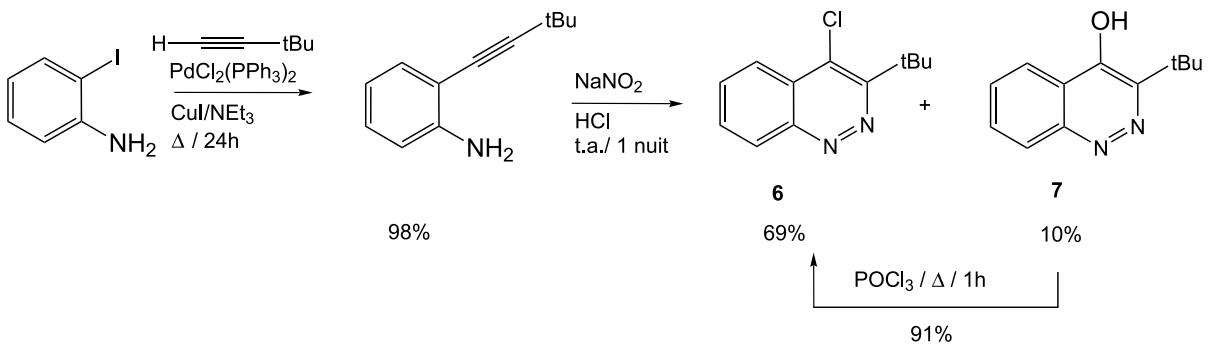


Scheme 1.

Table 1. Synthesis of sulfanyl and sulfinylcinnolines



Entry		Halocinnoline					Sulfide substrate				Yield (%)		Sulfoxide substrate				Yield (%)
		R_1	R_2	R_3	R_4		R_1	R_2	R_3	R_4			R_1	R_2	R_3	R_4	
1	**1**	H	Cl	H	H	**2a**	H	S*t*-Bu	H	H	93	**3a**	H	SO*t*-Bu	H	H	89
						2b	H	SPh	H	H	93	**3b**	H	SOPh	H	H	44
						2c	H	SCH_3	H	H	74						
2	**5**	H	Cl	OCH_3	OCH_3	**13a**	H	S*t*-Bu	OCH_3	OCH_3	86	**14a**	H	SO*t*-Bu	OCH_3	OCH_3	83
						13b	H	S*p*-Tol	OCH_3	OCH_3	92	**14b**	H	SO*p*-Tol	OCH_3	OCH_3	37
3	**6**	*t*-Bu	Cl	H	H	**15**	*t*-Bu	S*t*-Bu	H	H	95	**16**	*t*-Bu	SO*t*-Bu	H	H	49
4	**8**	OCH_3	I	H	H	**17**	OCH_3	SPh	H	H	93	**18**	OCH_3	SOPh	H	H	63
5	**9**	Cl	H	H	H	**19a**	S*t*-Bu	H	H	H	91	**20a**	SO*t*-Bu	H	H	H	66
						19b	S*p*-Tol	H	H	H	87	**20b**	SO*p*-Tol	H	H	H	76



Scheme 2.

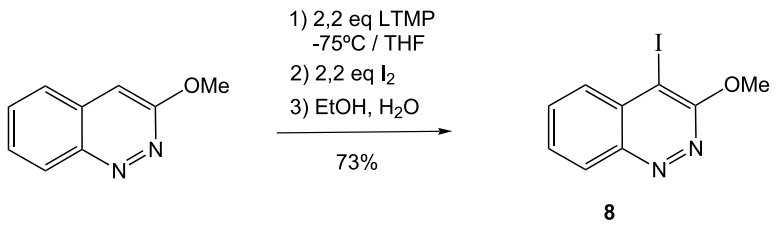
chlorination with phosphorous oxychloride into 4-chloro-3-*tert*-butylcinnoline **6** in 91% yield.

The synthesis of 4-iodo-3-methoxycinnoline **8** was performed with a 73% yield by metalation of 3-methoxycinnoline followed by reaction with iodine[27] (Scheme 3).

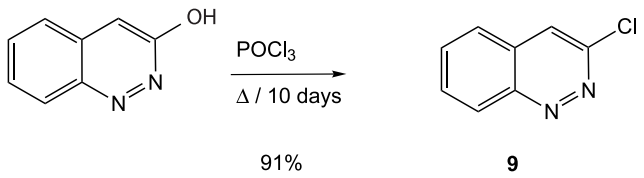
Preparation of 3-chlorocinnoline **9** was reported by Alford and Schofield[32] from 3-hydroxycinnoline in 9% yield. In our previous paper,[27] an increase of the chlorination time from 5 h to 6 days allowed us to obtain 3-chlorocinnoline **9** in better yield (72%); at present, a distinct improvement of the yield (91%) was achieved with still a longer chlorination time, from 6 days to 10 days (Scheme 4).

In the quinoxaline and quinazoline series, 2-chloroquinoxaline **10** and 4-chloro-2-phenylquinazoline **11** (Table 2, entries 1 and 2) used were both commercial compounds.

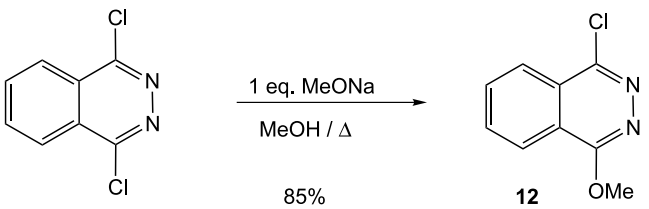
In the phtalazine series, 1-chloro-4-methoxyphtalazine **12**



Scheme 3.



Scheme 4.



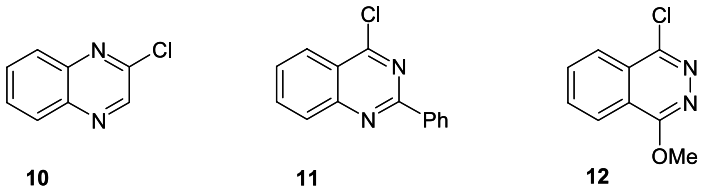
Scheme 5.

was prepared in 85% yield from commercial 1,4-dichlorophtalazine according to Druey and Ringier[33] (Scheme 5).

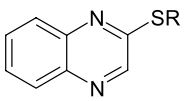
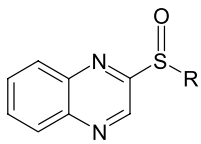
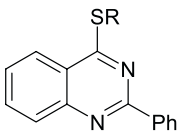
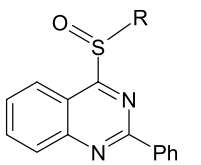
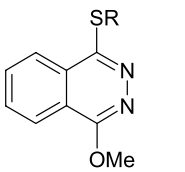
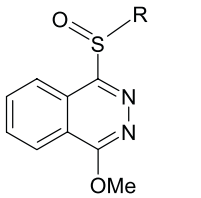
In the present work we describe an efficient synthesis of arylsulfanylbenzodiazines by aromatic substitution reaction of halogenobenzodiazines with the corresponding lithium thiolates. Thirteen alkyl and arylsulfanylbenzodiazines of which eleven are new **2a**–**b**, **13a**–**b**, **15**, **17**, **19a**–**b**, **21b**, **23**, **25** were obtained. These compounds have been oxidized with *m*-CPBA to afford the corresponding new substituted sulfinylbenzodiazines **3a**–**b**, **14a**–**b**, **16**, **18**, **20a**–**b**, **22b**, **24**, **26** as shown in Scheme 1 (Table 1 and Table 2) or for compound **2a** with potassium permanganate in acetic acid to obtain the 4-*tert*-butylsulfonylcinnoline **4** (Scheme 1). It must be noticed that yields obtained for each series were very satisfactory.

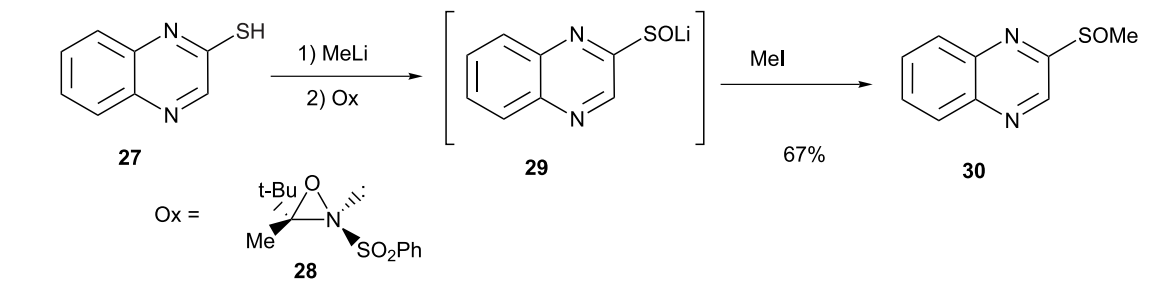
Starting from the 2-sulfanylquinoxaline **27**, we report also an improved synthesis of 2-methylsulfinylquinoxaline[34] **30** in one pot. By using the original method developed by Perrio[35] in the benzene series, we succeeded in obtaining the 2-methylsulfinylquinoxaline **30** in 67% yield (Scheme 6). The protocol developed involves three consecutive reactions carried out in one pot: deprotonation of the thiol **27** to generate the corresponding thiolate, oxidation with the *N*-sulfonyloxaziridine **28** into the corresponding sulfenate **29** and finally S-alkylation with methyl iodide. The present

Table 2. Synthesis of sulfanyl and sulfinylbenzodiazines



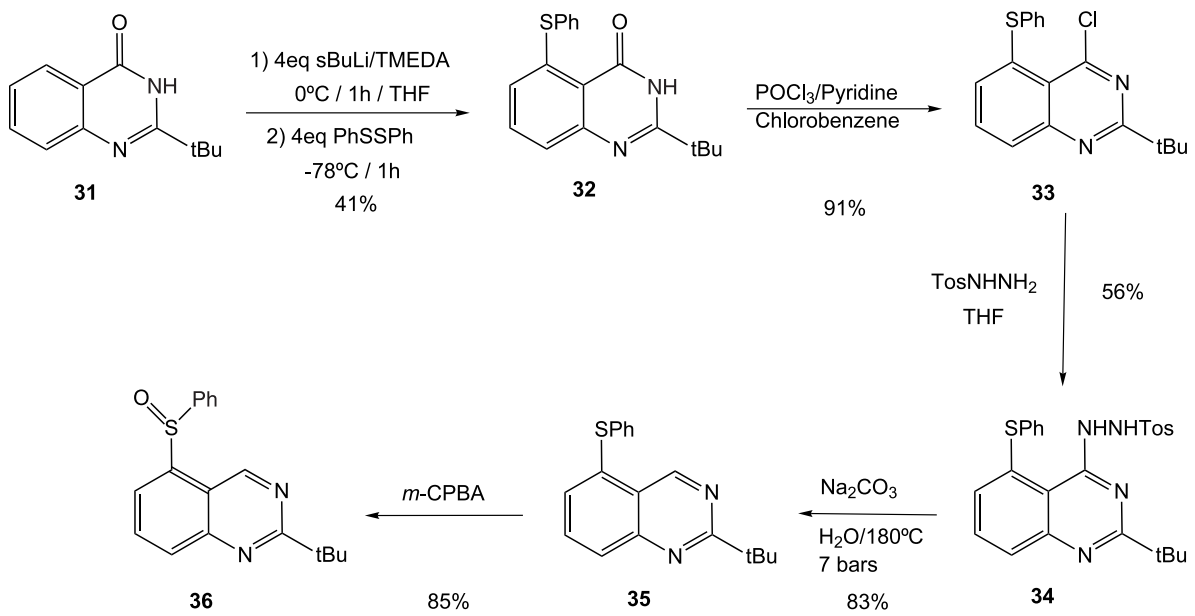
10 **11** **12**

Entry	Halodiazine	Sulfide substrate		Yield (%)	Sulfoxide substrate		Yield (%)
1	**10**		**21a** R=*t*-Bu	94		**22a** R=*t*-Bu	89
			21b R=*p*-Tol	87		**22b** R=*p*-Tol	90
2	**11**		**23** R=*t*-Bu	88		**24** R=*t*-Bu	77
3	**12**		**25** R=*t*-Bu	95		**26** R=*t*-Bu	83



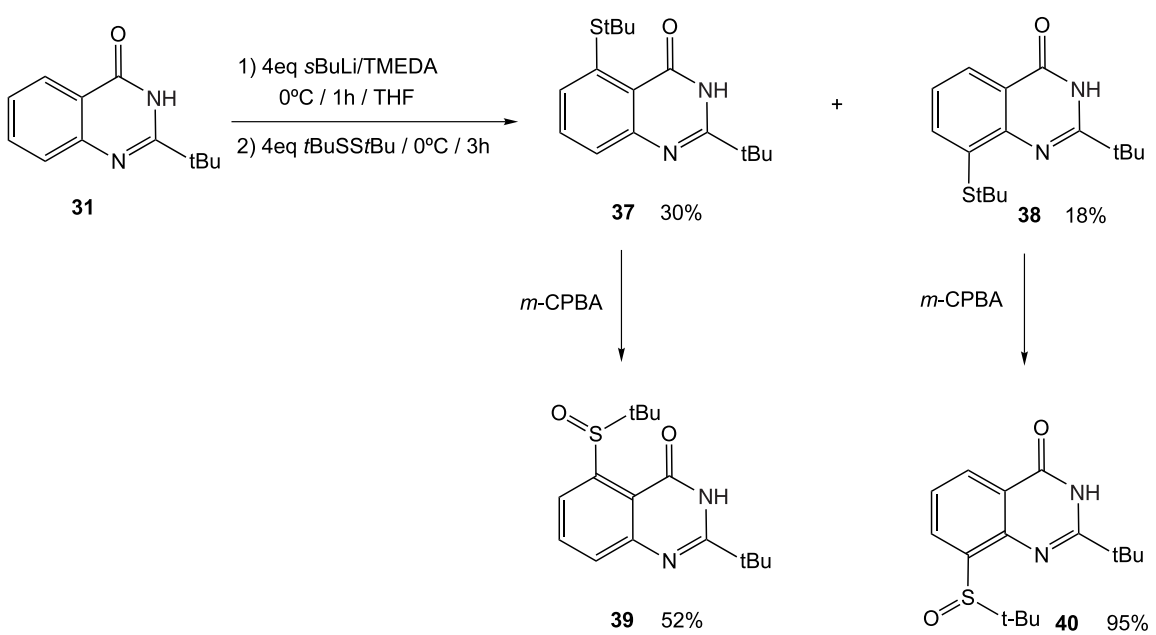
27 29 30 28

Scheme 6.



31 32 33 34 35 36

Scheme 7.



Scheme 8.

method could offer an efficient, simple and general synthetic procedure to access in one pot to sulfoxides of benzodiazines and their substituted derivatives, thus, complementing the known literature procedures for the synthesis of other benzodiazine derivatives.

All compounds synthesized so far, bear the sulfinyl moiety connected to the diazine ring of the benzodiazines. We also wished to prepare sulfoxides whose sulfur atom is connected to the benzene ring. In the quinazoline series, a new synthetic route (Scheme 7) and particularly the first metalation step has been developed in our group[36] to prepare 2-*tert*-butyl-5-phenylsulfanylquinazoline **35** with satisfactory yield from 2-*tert*-butyl-4(3*H*)-quinazolinone[37] **31**. The final oxidation step was achieved with *m*-CPBA, affording the corresponding 2-*tert*-butyl-5-phenylsulfinylquinazoline **36** with a yield of 85%.

By analogy (Scheme 8), metalation of the 2-*tert*-butyl-4(3*H*)-quinazolinone **31** followed by addition of *tert*-butyldisulfide allowed us to obtain 2-*tert*-butyl-5-*tert*-butylsulfanyl-4(3*H*)-quinazolinone **37** in 30% yield and 2-*tert*-butyl-8-*tert*-butylsulfanyl-4(3*H*)-quinazolinone **38** in 18% yield. Then, oxidation with *m*-CPBA afforded the corresponding 5- and 8-substituted sulfinyl-4(3*H*)-quinazolinone **39** and **40** with respective yields of 52% and 95%.

3. Conclusion

In conclusion, we report here a convenient synthesis of eleven new sulfinylbenzodiazines that employed halogenobenzodiazines as key intermediates. This route gave good yields and offered flexibility to introduce a variety of alkyl and/or aryl groups by choosing the appropriate alkylating agent (alkyl or arylthiolate) before the oxidation step with *m*-CPBA. Moreover, we have developed a one pot synthetic route to prepare the 2-methylsulfinylquinoxaline via the corresponding 2-sulfanylquinoxaline with satisfactory yield. We have also developed and improved a general method for the access to sulfinylquinazolines and sulfinyl-4(3*H*)-quinazolinones bearing the sulfinyl group in the benzene moiety. It used a metalation step to afford the corresponding alkyl and/or aryl sulfinyl-4(3*H*)-quinazolinone in moderate to good yields.

The study of metalation reactions of these sulfinylbenzodiazines is presently under investigation and will be reported soon.

4. Experimental

4.1. General

Melting points were measured on a Kofler hot-stage. NMR spectra were recorded in $CDCl_3$ or DMSO-d_6 with a Bruker Avance 300 spectrometer (^1H at 300 MHz and ^{13}C at 75 MHz). IR spectra were obtained as potassium bromide pellets with a Perkin Elmer Paragon 500 spectrometer. Elemental analyses were performed on a Carlo Erba 1106 apparatus. Mass spectra were recorded with a Jeol JMS-AX500 spectrometer.

Tetrahydrofuran (THF) was distilled from benzophenone sodium and used immediately (water content <60 ppm). Column chromatography were performed with silica gel Merck (70–230 mesh ASTM) or neutral alumina gel Acros (0.0050–0.200 mm). *m*-CPBA (3-chloroperoxybenzoic acid, balance 3-chlorobenzoic acid and water, 70–75%) was purchased from Acros. 2-Chloroquinoxaline **10**, 4-chloro-2-phenylquinazoline **11** and 1,4-dichlorophtalazine are available from Aldrich.

4.2. General procedure for the preparation of sulfides

To a stirred solution of thiol or disulfide in THF cooled at 0 °C, under an atmosphere of dry nitrogen, was added *n*-butyllithium (1.6 or 2.5 M in hexanes). The solution was stirred at this temperature for 10 min, then a THF solution of halogeno compound was added, the temperature was warmed to the indicated temperature (θ) and the reaction mixture stirred for the indicated time (t). Hydrolysis was carried out at room temperature using water. The solvent was evaporated and the aqueous layer was extracted with dichloromethane. The combined organic layers were dried over magnesium sulfate and evaporated. The crude product was purified by column chromatography on silica gel.

4.3. General procedure for the oxidation reaction of sulfides

Into a round bottomed two necked flask provided with magnetic stirring bar and under an atmosphere of nitrogen was placed a CH_2Cl_2 solution of sulfide. After cooling to −10 °C, a CH_2Cl_2 solution of *m*-CPBA (0.5 equiv.) was added dropwise, and the reaction mixture was stirred at −10 °C for 30 min. Additional *m*-CPBA (0.5 equiv.) dissolved in dichloromethane was then added dropwise and the mixture was stirred at −10 °C during 30 min. the solution was washed with aqueous $Na_2S_2O_4$ (5%), aqueous $NaHCO_3$ (5%) and water. The organic layer was dried over magnesium sulfate and evaporated. The crude product was purified by column chromatography on silica gel.

4.3.1. 4-*tert*-Butylsulfanylcinnoline (2a). Synthesis of **2a** was performed according to the general procedure for preparation of sulfides with 2-methyl-2-propanethiol (2.8 ml, 25.4 mmol) in 50 ml of THF, *n*-butyllithium 1.6 M (15.9 ml, 25.4 mmol) and 4-chlorocinnoline **1** (2.79 g, 16.9 mmol) dissolved in 10 ml of THF. θ=66 °C, t=2 h 30 min. A purification by column chromatography on silica gel with ether petroleum/ethyl acetate (7/3) as eluent gave **2a** (3.44 g, 93%) as a yellow solid. Mp=70 °C. ^1H NMR ($CDCl_3$): δ=9.23 (s, 1H, H_3); 8.32 (m, 2H, H_5+H_8); 7.64 (m, 2H, H_6+H_7); 1.23 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=150.8 (C); 150.6 (CH); 132.5 (C); 131.7 (CH); 131.1 (CH); 130.5 (CH); 129.9 (C); 125.7 (CH); 49.7 (C); 31.8 (CH_3). IR (KBr) (cm^{-1}): 2962, 1610, 1552, 1478, 1389, 1370, 1229, 1156, 765, 674. Anal. calcd for $C_{12}H_{14}N_2S$: C, 65.96; H, 6.41; N, 12.83; S, 14.70. Found: C, 66.04; H, 6.18; N, 12.62; S, 14.96%.

4.3.2. 4-Phenylsulfanylcinnoline (2b). Synthesis of **2b** was

performed according to the general procedure for preparation of sulfides with thiophenol (0.4 ml, 3.65 mmol) in 15 ml of THF, *n*-butyllithium 1.6 M (2.3 ml, 3.65 mmol) and 4-chlorocinnoline **1** (0.5 g, 3.04 mmol) dissolved in 10 ml of THF. θ=66 °C, t=2 h 30 min. A purification by column chromatography on silica gel with dichloromethane/ethyl acetate (8/2) as eluent gave **2b** (0.67 g, 93%) as a yellow solid. Mp=135 °C. ^{1}H NMR ($CDCl_3$): δ=8.54 (s, 1H, H_3); 8.40 (d, J_{8-7}=9.0 Hz, 1H, H_8); 8.06 (d, J_{5-6}=7.9 Hz, 1H, H_5); 7.74 (m, 2H, H_6+H_7); 7.55 (m, 2H, SPh); 7.44 (m, 3H, SPh). ^{13}C NMR ($CDCl_3$): δ=147.5 (C); 140.6 (CH); 137.7 (C); 134.3 (CH); 129.9 (CH); 129.7 (CH); 129.3 (CH); 129.2 (CH); 129.0 (CH); 126.5 (C); 122.8 (C); 121.6 (CH). IR (KBr) (cm^{-1}): 3058, 1614, 1555, 1480, 1396, 1225, 754, 672, 552. Anal. calcd for $C_{14}H_{10}N_2S$: C, 70.56; H, 4.23; N, 11.75; S, 13.46. Found: C, 70.38; H, 4.28; N, 11.67; S, 13.39%.

4.3.3. 4-Methylsulfanylcinnoline (2c). Synthesis of **2c** was performed according to the general procedure for preparation of sulfides with methyl disulfide (0.65 ml, 7.32 mmol) in 10 ml of THF, *n*-butyllithium 1.6 M (4.58 ml, 7.32 mmol) and 4-chlorocinnoline **1** (1 g, 6.1 mmol) dissolved in 10 ml of THF. θ=66 °C, t=1 h 10 min. A purification by column chromatography on silica gel with dichloromethane/ethyl acetate (1/1) as eluent gave **2c** (0.79 g, 74%) as a yellow solid. Mp=96 °C (lit.[38]= 98 °C). ^{1}H NMR ($CDCl_3$): δ=9.01 (s, 1H, H_3); 8.40 (d, J_{8-7}=8.5 Hz, 1H, H_8); 7.91 (d, J_{5-6}=8.2 Hz, 1H, H_5); 7.72 (m, 2H, H_6+H_7); 2.63 (s, 3H, CH_3).

4.3.4. 4-*tert*-Butylsulfinylcinnoline (3a). Oxidation of a solution of 4-*tert*-butylsulfanylcinnoline **2a** (3.27 g, 15 mmol), in dichloromethane (250 ml), was performed according to the general procedure with *m*-CPBA (2×1.85 g, 2×7.5 mmol) dissolved in dichloromethane (2×60 ml), giving after purification by column chromatography on silica gel with ethyl acetate as eluent, **3a** (3.12 g, 89%) as a orange solid. Mp=117 °C. ^{1}H NMR ($CDCl_3$): δ=9.57 (s, 1H, H_3); 8.59 (d, J_{7-8}=8.5 Hz, 1H, H_8); 8.14 (d, J_{5-6}=8.0 Hz, 1H, H_5,); 7.85 (m, 2H, H_6+H_7); 1.23 (s, 9H, $(CH_3)_3$). ^{13}C NMR ($CDCl_3$): δ=150.1 (C_9); 142.1 (C_3); 136.2 (C_4); 132.7 (C_6); 131.6 (C_7); 131.0 (C_8); 124.4 (C_{10}); 123.2 (C_5); 59.7 (C, *t*Bu); 23.7 (CH_3, *t*Bu). IR (KBr) (cm^{-1}): 2868–3100, 1611, 1552, 1483, 1397, 1366, 1167, 1048, 784, 670. Anal. calcd for $C_{12}H_{14}N_2OS$: C, 61.45; H, 5.97; N, 11.95; S, 13.70. Found: C, 61.22; H, 5.98; N, 11.92; S, 13.56%.

4.3.5. 4-Phenylsulfinylcinnoline (3b). Oxidation of a solution of 4-phenylsulfanylcinnoline **2b** (0.20 g, 0.84 mmol), in dichloromethane (20 ml), was performed according to the general procedure with *m*-CPBA (2×0.11 g, 2×0.42 mmol) dissolved in dichloromethane (2×5 ml), giving after purification by column chromatography on silica gel with a mixture of ethyl acetate/ether petroleum (1/1) as eluent, **3b** (94 mg, 44%) as a yellow solid. Mp=157 °C. ^{1}H NMR ($CDCl_3$): δ=9.72 (s, 1H, H_3); 8.56 (d, J_{7-8}=8.42 Hz, 1H, H_8); 8.10 (d, J_{5-6}=7.54 Hz, 1H, H_5); 7.76 (m, 4H, H_6+H_7 and 2H of SOPh); 7.39 (m, 3H, SOPh). ^{13}C NMR ($CDCl_3$): δ=150.5 (C); 143.3 (C); 140.0 (C); 139.6 (CH); 133.1 (CH); 132.6 (CH); 131.7 (CH); 131.4 (CH); 130.3 (CH); 125.9 (CH); 122.1 (CH); 121.8 (C). IR (KBr) (cm^{-1}): 3056, 1610, 1556, 1439, 1403, 1145, 1051, 767, 746, 685. Anal. calcd for $C_{14}H_{10}N_2OS$: C, 66.12; H, 3.96; N, 11.02; S, 12.61. Found: C, 66.22; H, 4.15; N, 10.91; S, 12.35%.

4.3.6. 4-*tert*-Butylsulfonylcinnoline (4). 4-*tert*-Butylsulfanylcinnoline **2a** (0.3 g, 1.37 mmol) in acetic acid (20 ml, 8 N) was stirred at room temperature while $KMnO_4$ (0.8 g, 5.06 mmol) in water (30 ml) was added during 30 min. the reaction mixture was chilled to 15 °C and decolourised by an aqueous solution of Na_2SO_3 (5%). 4-*tert*-butylsulfonylcinnoline **4** was collected to give (0.2 g, 59%) as a yellow solid. Mp=140 °C. ^{1}H NMR ($CDCl_3$): δ=9.59 (s, 1H); 8.82 (m, 1H); 8.64 (m, 1H); 7.91 (m, 2H); 1.34 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=(152.2 (C); 145.8 (CH); 134.3 (CH); 131.9 (CH); 131.4 (CH); 128.4 (C); 125.0 (CH); 123.0 (C); 62.8 (C); 23.9 (CH_3). IR (KBr) (cm^{-1}): 2939–3091, 1483, 1374, 1306, 1147, 1116, 763, 693, 580, 489. Anal. calcd for $C_{12}H_{14}N_2O_2S$: C, 57.53; H, 5.59; N, 11.19; S, 12.82. Found: C, 57.42; H, 5.28; N, 11.17; S, 12.58%.

4.3.7. 6,7-Dimethoxy-4-*tert*-butylsulfinylcinnoline (6a). Oxidation of a solution of 6,7-dimethoxy-4-*tert*-butylsulfanylcinnoline **13a** (1.02 g, 3.59 mmol) in dichloromethane (60 ml), was performed according to the general procedure with *m*-CPBA (2×0.44 g, 2×1.8 mmol) dissolved in dichloromethane (2×5 ml), giving after purification by column chromatography on silica gel with ethyl acetate as eluent, **6a** (0.876 g, 83%) as yellow solid. Mp=172 °C. ^{1}H NMR ($CDCl_3$): δ=9.38 (s, 1H); 8.09 (s, 1H); 7.79 (s, 1H); 4.07 (s, 3H); 4.04 (s, 3H); 1.34 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=156.2 (C); 154.1 (C); 145.1 (CH); 126.1 (C); 121.5 (C); 107.9 (CH); 101.4 (CH); 63.0 (C); 57.2 (CH_3); 57.0 (CH_3); 23.9 (CH_3). IR (KBr) (cm^{-1}): 2990–3120, 1495, 1298, 1117, 576. Anal. calcd for $C_{14}H_{18}N_2O_3S$: C, 57.12; H, 6.16; N, 9.52. Found: C, 56.65; H, 6.06; N, 9.27%.

4.3.8. 6,7-Dimethoxy-4-*p*-tolylsulfinylcinnoline (6b). Oxidation of a solution of 6,7-dimethoxy-4-*p*-tolylsulfanylcinnoline **13b** (0.15 g, 0.48 mmol) in dichloromethane (20 ml), was performed according to the general procedure with *m*-CPBA (2×0.06 g, 2×0.24 mmol) dissolved in dichloromethane (2×2 ml), giving after purification by column chromatography on silica gel with a mixture of dichloromethane/acetone (4/1) as eluent, **6b** (0.06 g, 37%) as yellow solid. Mp=242 °C. ^{1}H NMR ($CDCl_3$): δ=9.42 (s, 1H); 7.71 (s, 1H); 7.53 (d, J=8.3 Hz, 2H); 7.26 (s, 1H); 7.20 (d, J=7.9 Hz, 2H); 4.00 (s, 3H); 3.93 (s, 3H); 2.29 (s, 3H). ^{13}C NMR ($CDCl_3$): δ=155.0 (C); 153.9 (C); 149.2 (C); 143.3 (C); 140.0 (C); 139.4 (CH); 137.1 (C); 130.8 (CH); 125.9 (CH); 119.6 (C); 108.0 (CH); 98.8 (CH); 57.0 (CH_3); 56.9 (CH_3); 21.8 (CH_3). IR (KBr) (cm^{-1}): 2854–3079, 14,989, 1428, 1297, 1258, 1216, 1055, 1011, 819, 510. Anal. calcd for $C_{17}H_{16}N_2O_3S$: C, 62.18; H, 4.91; N, 8.53. Found: C, 61.92; H, 4.53; N, 8.35%.

4.3.9. 4-Chloro-3-*tert*-butylcinnoline (6) and 3-*tert*-butylcinnolin-4-ol (7). A suspension of 2-(3,3-dimethyl-1-butynyl)-phenylamine (0.5 g, 2.89 mmol) in 5 ml of water was stirred and cooled to 0 °C. 5 ml of a 36% aqueous solution of aqueous hydrochloric acid was added then, dropwise, a solution of $NaNO_2$ (0.31 g, 4.49 mmol) dissolved in 1 ml of water. The reaction mixture was

warmed to room temperature and stirred for 2 h. After neutralization with a saturated aqueous solution of $NaHCO_3$ and extraction with dichloromethane, the organic layer was dried over magnesium sulfate and evaporated. A purification by column chromatography on silica gel with ether petroleum/ethyl acetate (8/2) as eluent gave **6** in a first fraction (0.38 g, 59%) as a yellow solid. Mp=113 °C. ^{1}H NMR ($CDCl_3$): δ=8.35 (d, J=6.7 Hz, 1H); 8.12 (d, J=7.5 Hz, 1H); 7.66 (m, 2H); 1.62 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=159.3 (C); 150.2 (C); 134.3 (C); 132.0 (CH); 130.6 (CH); 130.0 (CH); 126.2 (C); 123.5 (CH); 39.3 (C); 29.7 (CH_3). IR (KBr) (cm^{-1}):2865–3100, 1458, 1338, 1160, 995, 850, 775, 706. Anal. calcd for $C_{12}H_{13}N_2Cl$: C, 65.31; H, 5.94; N, 12.69. Found: C, 65.70; H, 6.26; N, 13.14%.

A second fraction gave 3-*tert*-butylcinnolin-4-ol **7** (69 mg, 12%) as a white solid. Mp=244 °C. ^{1}H NMR (DMSO-d_6): δ=8.16 (d, J=7.2 Hz, 1H); 7.84 (dd, J=7.7, 7.7 Hz, 1H); 7.63 (d, J=8.7 Hz, 1H); 7.46 (dd, J=7.6, 7.6 Hz, 1H); 1.50 (s, 9H). ^{13}C NMR (DMSO-d_6): δ=169.8 (C); 154.9 (C); 141.1 (C); 133.5 (CH); 124.6 (CH); 124.2 (CH); 122.8 (C); 37.1 (C); 28.1 (CH_3). IR (KBr) (cm^{-1}): 2700–3200, 1554, 1478, 1360, 1146, 757. Anal. calcd for $C_{12}H_{14}N_2O$: C, 71.26; H, 6.98; N, 13.85. Found: C, 71.23; H, 6.92; N, 13.37%.

3-*tert*-Butylcinnolin-4-ol **7** (0.1 g, 0.49 mmol) can be chlorinated by refluxing in phosphorus oxychloride (5 ml) for 1 h. After evaporation of phosphorus oxychloride, the mixture was poured into ice water (5 ml) and neutralized with a saturated aqueous solution of potassium carbonate. The aqueous layer was extracted with dichloromethane. The combined organic layer was dried over magnesium sulfate and evaporate A purification by column chromatography on silica gel with dichloromethane as eluent gave 4-chloro-3-*tert*-butylcinnoline **6** (98 mg, 91%).

4.3.10. 1-Chloro-4-methoxyphtalazine (12). Sodium (0.46 g, 20.10 mmol) was dissolved in 180 ml of dry methanol, then 1,4-dichlorophtalazine was added and the reaction mixture was refluxing for 30 min. The hot solution was filtered and evaporated. The crude product was crystallised from cyclohexane giving **12** (3.33 g, 85%) as a white solid. Mp=107 °C (lit.[33] 108 °C). ^{1}H NMR ($CDCl_3$): δ=8.14 (m, 2H, H_5+H_8); 7.86 (m, 2H, H_6+H_7); 4.20 (s, 3H, OCH_3). ^{13}C NMR ($CDCl_3$): δ=161.0 (C); 150.5 (C); 133.5 (CH); 132.1 (CH); 127.9 (C); 125.5 (CH); 123.9 (CH); 121.9 (C); 55.6 (CH_3). IR (KBr) (cm^{-1}): 2860–3079, 144.8, 1366, 1337, 1293, 964, 774, 661. Anal. calcd for $C_9H_7N_2OCl$: C, 55.54; H, 3.63; N, 14.39. Found: C, 55.29; H, 3.68; N, 14.48%.

4.3.11. 6,7-Dimethoxy-4-*tert*-butylsulfanylcinnoline (13a). Synthesis of **13a** was performed according to the general procedure for preparation of sulfides with 2-methyl-2-propanethiol (1.87 ml, 17.36 mmol) in 50 ml of THF, *n*-butyllithium 2.5 M (6.94 ml, 17.36 mmol) and 4-chloro-6,7-dimethoxycinnoline **5** (2.6 g, 11.57 mmol) dissolved in 10 ml of THF. θ=66 °C, t=2 h. A purification by column chromatography on silica gel with ethyl acetate as eluent gave **13a** (2.76 g, 86%) as a yellow solid. Mp=180 °C. ^{1}H NMR ($CDCl_3$): δ=9.06 (s, 1H, H_3); 7.57 (s, 1H); 7.50 (s, 1H); 3.99 (s, 3H); 3.97 (s, 3H); 1.26 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=154.3 (C); 153.6 (C); 150.5 (CH); 129.2 (C); 127.8 (C); 107.1 (CH); 102.1 (CH); 56.8 (CH_3); 56.7 (CH_3); 49.7 (C); 31.7 (CH_3). IR (KBr) (cm^{-1}): 2837–2996, 1494, 1428, 1300, 1226, 1157, 1015, 857, 793. Anal. calcd for $C_{14}H_{18}N_2O_2S$: C, 60.41; H, 6.52; N, 10.06. Found: C, 60.39; H, 6.86; N, 9.94%.

4.3.12. 6,7-Dimethoxy-4-*p*-tolylsulfanylcinnoline (13b). Synthesis of **13b** was performed according to the general procedure for preparation of sulfides with *p*-toluenethiol (0.17 g, 1.36 mmol) in 15 ml of THF, *n*-butyllithium 1.6 M (0.85 ml, 1.36 mmol) and 4-chloro-6,7-dimethoxycinnoline **5** (0.2 g, 0.89 mmol) dissolved in 10 ml of THF. θ=66 °C, t=2 h. A purification by column chromatography on silica gel with ethyl acetate as eluent gave **13b** (0.26 g, 92%) as a pale yellow solid. Mp=177 °C. ^{1}H NMR ($CDCl_3$): δ=8.52 (s, 1H, H3); 7.69 (s, 1H); 7.49 (d, J=7.9 Hz, 2H, *p*-tol); 7.3 (d, J=8.3 Hz, 2H, *p*-tol); 7.22 (s, 1H); 4.11 (s, 3H); 4.08 (s, 3H); 2.44 (s, 3H). ^{13}C NMR ($CDCl_3$): δ=153.8 (C); 153.7 (C); 147.1 (C); 142.1 (CH); 140.7 (C); 136.4 (C); 135.3 (CH); 131.4 (CH); 125.1 (C); 121.4 (C); 107.4 (CH); 100.0 (CH); 56.9 (CH_3); 56.8 (CH_3); 21.7 (CH_3). IR (KBr) (cm^{-1}): 2826–3027, 1496, 1424, 1252, 1159, 1017, 822, 791. Anal. calcd for $C_{17}H_{16}N_2O_2S$: C, 65.36; H, 5.16; N, 8.97. Found: C, 65.43; H, 5.25; N, 8.96%.

4.3.13. 3-*tert*-Butyl-4-*tert*-butylsulfanylcinnoline (15). Synthesis of **15** was performed according to the general procedure for preparation of sulfides with 2-methyl-2-propanethiol (1.02 ml, 9.32 mmol) in 50 ml of THF, *n*-butyllithium 1.6 M (5.83 ml, 9.32 mmol) and 4-chloro-3-*tert*-butylcinnoline **6** (1.37 g, 6.21 mmol) dissolved in 10 ml of THF. θ=20 °C, t=2 h. A purification by column chromatography on silica gel with dichloromethane as eluent gave **15** (1.59 g, 93%) as a yellow solid. Mp=86 °C. ^{1}H NMR ($CDCl_3$): δ=8.52 (d, J_{8-7}=8.0 Hz, 1H, H_8); 8.36 (d, J_{5-6}=8.1 Hz, 1H, H_5); 7.63 (m, 2H, H_6+H_7); 1.67 (s, 9H, *t*Bu); 1.13 (s, 9H, S-*t*Bu). ^{13}C NMR ($CDCl_3$): δ=166.0 (C); 149.6 (C); 132.0 (C); 131.3 (C); 130.3 (CH); 129.9 (CH); 129.6 (CH); 127.9 (CH); 51.9 (C); 40.5 (C); 32.8 (CH_3); 32.0 (CH_3). IR (KBr) (cm^{-1}): 2863–2987, 1459, 1364, 1158, 1071, 769. Anal. calcd for $C_{16}H_{22}N_2S$: C, 70.03; H, 8.08; N, 10.21. Found: C, 70.02; H, 8.03; N, 10.05%.

4.3.14. 3-*tert*-Butyl-4-*tert*-butylsulfinylcinnoline (16). Oxidation of a solution of 3-*tert*-butyl-4-*tert*-butylsulfanylcinnoline **15** (0.10 g, 0.36 mmol)), in dichloromethane (15 ml), was performed according to the general procedure with *m*-CPBA (2×0.05 g, 2×0.18 mmol) dissolved in dichloromethane (2×5 ml), giving after purification by column chromatography on silica gel with a mixture of ethyl cyclohexane/acetate (7/3) as eluent, **16** (0.05 g, 49%) as a yellow oil. ^{1}H NMR ($CDCl_3$): δ=9.42 (d, J=8.3 Hz, 1H); 8.47 (d, J=8.7 Hz, 1H); 7.75 (ddd, J=1.5, 8.5, 7.2 Hz, 1H); 7.64 (ddd, J=1.5, 8.7, 7.8 Hz, 1H); 1.68 (s, 9H); 1.14 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=161.8 (C); 150.0 (C); 131.1 (CH); 130.9 (C); 130.6 (CH); 130.0 (CH); 126.7 (C); 126.2 (CH); 62.2 (C); 41.2 (C); 33.6 (CH_3); 26.3 (CH_3). IR (KBr) (cm^{-1}): 2967–3252, 1613, 1477, 1461, 1362, 1161, 1130, 760. HRMS (FAB$^+$) calcd for (MH^+) $C_{16}H_{23}N_2OS$: *m*/*z* 291.1531. Found: 291.1536.

4.3.15. 3-Methoxy-4-phenylsulfanylcinnoline (17). Synthesis of **17** was performed according to the general procedure for preparation of sulfides with thiophenol (0.14 ml, 1.24 mmol) in 15 ml of THF, *n*-butyllithium 1.6 M (0.77 ml, 1.24 mmol) and 4-iodo-3-methoxycinnoline **8** (0.29 g, 1.03 mmol) dissolved in 5 ml of THF. θ=20 °C, t=24 h. A purification by column chromatography on silica gel with ether petroleum/ethyl acetate (2/1) as eluent gave **17** (0.26 g, 93%) as a yellow solid. Mp=87 °C. ^{1}H NMR ($CDCl_3$): δ=8.32 (m, 1H); 8.17 (m, 1H); 7.54 (m, 2H); 7.10 (m, 5H); 4.17 (s, 3H, CH_3). ^{13}C NMR ($CDCl_3$): δ=161.4 (C); 149.5 (C); 134.7 (C); 132.1 (CH); 131.3 (C); 130.6 (CH); 129.5 (CH); 128.4 (CH); 127.2 (CH); 124.7 (CH); 116.4 (C); 56.4 (CH_3). IR (KBr) (cm^{-1}): 2900–3056, 1616, 1550, 1523, 1459, 1324, 1112, 766, 741, 693. Anal. calcd for $C_{15}H_{12}N_2OS$: C, 67.15; H, 4.50; N, 10.44; S, 11.95. Found: C, 67.22; H, 4.56; N, 10.33; S, 11.53%.

4.3.16. 3-Methoxy-4-phenylsulfinylcinnoline (18). Oxidation of a solution of 3-methoxy-4-phenylsulfanylcinnoline **17** (0.21 g, 0.78 mmol)), in dichloromethane (20 ml), was performed according to the general procedure with *m*-CPBA (2×0.10 g, 2×0.39 mmol) dissolved in dichloromethane (2×5 ml), giving after purification by column chromatography on silica gel with a mixture of ether petroleum/ethyl acetate (1/2) as eluent, **18** (0.14 g, 63%) as a yellow solid. Mp=146 °C. ^{1}H NMR ($CDCl_3$): δ=9.01 (d, J=8.8 Hz 1H); 8.35 (d, J=8.2 Hz, 1H); 7.73 (d, J=7.7 Hz, 2H, SPh); 7.60 (m, 2H, H_6+H_7); 7.37 (m, 3H, SPh); 4.34 (s, 3H, OCH_3). ^{13}C NMR ($CDCl_3$): δ=157.4 (C); 150.4 (C); 143.9 (C, SOPh); 133.0 (CH); 131.5 (CH); 131.2 (CH); 129.7 (CH, SOPh); 128.8 (CH); 126.7 (C); 124.9 (CH, SOPh); 122.3 (CH); 122.0 (C). IR (KBr) (cm^{-1}): 2951–3022, 1610, 1556, 1528, 1458, 1319, 1117, 1046, 773, 743, 688. Anal. calcd for $C_{15}H_{12}N_2O_2S$: C, 63.38; H, 4.26; N, 9.85; S, 11.28. Found: C, 63.19; H, 4.24; N, 9.81; S, 11.12%.

4.3.17. 3-*tert*-Butylsulfanylcinnoline (19a). Synthesis of **19a** was performed according to the general procedure for preparation of sulfides with 2-methyl-2-propanethiol (1 ml, 9.11 mmol) in 50 ml of THF, *n*-butyllithium 1.6 M (5.69 ml, 9.11 mmol) and 3-chlorocinnoline **9** (1 g, 6.08 mmol) dissolved in 10 ml of THF. θ=66 °C, t=2 h. A purification by column chromatography on silica gel with dichloromethane/ethyl acetate (9/1) as eluent gave **19a** (1.21 g, 91%) as a yellow solid. Mp=69 °C. ^{1}H NMR ($CDCl_3$): δ=8.38 (d, J=8.3 Hz, 1H); 7.84 (s, 1H); 7.65 (m, 3H); 1.44 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=155.0 (C); 149.3 (C); 131.8 (CH); 130.9 (CH); 130.0 (CH); 127.5 (CH); 126.5 (CH); 126.4 (C); 48.9 (C); 31.7 (CH_3). IR (KBr) (cm^{-1}): 2865–3042, 1424, 1366, 1166, 1140, 1105, 764, 750. Anal. calcd for $C_{12}H_{14}N_2S$: C, 66.02; H, 6.46; N, 12.83; S, 14.69. Found: C, 65.61; H, 6.66; N, 12.74; S, 14.34%.

4.3.18. 3-*p*-Tolylsulfanylcinnoline (19b). Synthesis of **19b** was performed according to the general procedure for preparation of sulfides with *p*-toluenethiol (0.23 g, 1.82 mmol) in 5 ml of THF, *n*-butyllithium 1.6 M (1.14 ml, 1.82 mmol) and 3-chlorocinnoline **9** (0.2 g, 1.22 mmol) dissolved in 5 ml of THF. θ=66 °C, t=2 h. A purification by column chromatography on silica gel with ether petroleum/ethyl acetate (7/3) as eluent gave **19b** (0.27 g, 87%) as a yellow solid. Mp=117 °C. ^{1}H NMR ($CDCl_3$): δ=8.37 (d, J=8.1 Hz, 1H); 7.60 (m, 2H); 7.47 (m, 3H); 7.20 (m, 3H); 2.36 (s, 3H). ^{13}C NMR ($CDCl_3$): δ=160.2 (C); 149.1 (C); 140.3 (C); 135.5 (CH); 131.9 (CH); 131.3 (CH); 130.1 (CH); 130.0 (CH); 127.1 (C); 126.9 (C); 126.2 (CH); 119.5 (CH); 21.8 (CH_3). IR (KBr) (cm^{-1}): 2906–3036, 1494, 1427, 1103, 1044, 809, 755, 515. Anal. calcd for $C_{15}H_{12}N_2S$: C, 71.40; H, 4.79; N, 11.10; S, 12.71. Found: C, 71.58; H, 4.95; N, 10.98; S, 12.46%.

4.3.19. 3-*tert*-Butylsulfinylcinnoline (20a). Oxidation of a solution of 3-*tert*-butylsulfanylcinnoline **19a** (5.34 g, 24.46 mmol)), in dichloromethane (300 ml), was performed according to the general procedure with *m*-CPBA (2×3.02 g, 2×12.23 mmol) dissolved in dichloromethane (2×50 ml), giving after purification by column chromatography on silica gel with a mixture of dichloromethane/ethyl acetate (4/1) as eluent, **20a** (8.81 g, 66%) as a beige solid. Mp=129 °C. ^{1}H NMR ($CDCl_3$): δ=8.60 (d, J_{8-7}=9.4 Hz, 1H, H_8); 8.48 (s, 1H, H_4); 7.94 (m, 2H, H_5+H-*Ar*); 7.86 (m, 1H, H-*Ar*); 1.29 (s, 9H, *t*Bu). ^{13}C NMR ($CDCl_3$): δ=160.6 (C); 151.2 (C); 132.6 (CH); 132.5 (CH); 130.3 (CH); 127.6 (CH); 126.7 (C); 122.2 (CH); 58.5 (C); 23.6 (CH_3). IR (KBr) (cm^{-1}): 2863–3100, 1389, 1365, 1174, 1060, 1034, 774. Anal. calcd for $C_{12}H_{14}N_2OS$: C, 61.45; H, 5.97; N, 11.95; S, 13.70. Found: C, 61.46; H, 6.23; N, 11.95; S, 13.43%.

4.3.20. 3-*p*-Tolylsulfinylcinnoline (20b). Oxidation of a solution of 3-*p*-tolylsulfanylcinnoline **19b** (0.21 g, 0.83 mmol)), in dichloromethane (20 ml), was performed according to the general procedure with *m*-CPBA (2×0.11 g, 2×0.42 mmol) dissolved in dichloromethane (2×5 ml), giving after purification by column chromatography on silica gel with a mixture of dichloromethane/ethyl acetate (8/2) as eluent, **20b** (0.17 g, 76%) as a beige solid. Mp=189 °C. ^{1}H NMR ($CDCl_3$): δ=8.59 (m, 2H); 7.94 (m, 5H); 7.30 (d, J=8.3 Hz, 2H); 2.37 (s, 3H). ^{13}C NMR ($CDCl_3$): δ=163.6 (C); 151.2 (C); 142.5 (C); 140.8 (C); 132.7 (CH); 132.4 (CH); 130.4 (CH); 130.3 (CH); 127.6 (CH); 127.0 (C); 125.3 (CH); 119.1 (CH); 21.8 (CH_3). IR (KBr) (cm^{-1}): 2854–3040, 1389, 1085, 1057, 1035, 807, 755. Anal. calcd for $C_{15}H_{12}N_2OS$: C, 67.14; H, 4.51; N, 10.44. Found: C, 67.06; H, 4.72; N, 10.31%.

4.3.21. 2-*tert*-Butylsulfanylquinoxaline (21a). Synthesis of **21a** was performed according to the general procedure for preparation of sulfides with 2-methyl-2-propanethiol (3.33 ml, 30.44 mmol) in 100 ml of THF, *n*-butyllithium 2.5 M (12.18 ml, 30.44 mmol) and 2-chloroquinoxaline **10** (3.34 g, 20.29 mmol) dissolved in 50 ml of THF. θ=66 °C, t=2 h. A purification by column chromatography on silica gel with dichloromethane as eluent gave **21a** (4.42 g, 92%) as a pale yellow solid. Mp=63 °C (lit.[39]=60–61 °C). ^{1}H NMR ($CDCl_3$): δ=8.44 (s, 1H); 7.87 (m, 2H); 7.55 (m, 2H); 1.60 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=157.6 (C); 146.4 (CH); 142.8 (C); 139.9 (C); 130.3 (CH); 129.6 (CH); 128.5 (CH); 49.4 (C); 30.7 (CH_3). IR (KBr) (cm^{-1}): 2901–3061, 1543, 1358, 1149, 1078, 962, 757. Anal. calcd for $C_{12}H_{14}N_2S$: C, 66.02; H, 6.46; N, 12.83. Found: C, 66.17; H, 6.57; N, 12.54%.

4.3.22. 2-*p*-Tolylsulfanylquinoxaline (21b). Synthesis of

21b was performed according to the general procedure for preparation of sulfides with *p*-toluenethiol (9.1 g, 72.92 mmol) in 150 ml of THF, *n*-butyllithium 2.5 M (29.2 ml, 73 mmol) and 2-chloroquinoxaline **10** (10 g, 60.77 mmol) dissolved in 50 ml of THF. θ=66 °C, t=2 h. A purification by column chromatography on silica gel with dichloromethane/ether petroleum (2/1) as eluent gave **21b** (14.47 g, 94%) as a yellow solid. Mp=61 °C. ^{1}H NMR ($CDCl_3$): δ=8.32 (s, 1H, H_3); 7.90 (dd, J=8.1, 1.5 Hz, 1H); 7.82 (dd, J=8.5, 1.5 Hz, 1H); 7.58 (m, 2H, H_6+H_7); 7.48 (d, J=8.3 Hz, 2H, *p*-tolyl); 7.20 (d, J=7.9 Hz, 2H, *p*-tolyl); 2.36 (s, 3H, CH_3). ^{13}C NMR ($CDCl_3$): δ=158.1 (C); 143.6 (CH); 142.5 (C); 140.5 (C); 140.2 (C); 135.5 (CH); 131.1 (CH); 130.8 (CH); 129.5 (CH); 129.0 (CH); 128.7 (CH); 125.5 (C); 21.8 (CH_3). IR (KBr) (cm^{-1}): 2916–3056, 1542, 1079, 961, 806, 756, 508. Anal. calcd for $C_{15}H_{12}N_2S$: C, 71.40; H, 4.79; N, 11.10. Found: C, 71.48; H, 4.54; N, 11.70%.

4.3.23. 2-*tert*-Butylsulfinylquinoxaline (22a). Oxidation of a solution of 2-*tert*-butylsulfanylquinoxaline **21a** (2 g, 8.41 mmol)), in dichloromethane (150 ml), was performed according to the general procedure with *m*-CPBA (2×1.04 g, 2×4.21 mmol) dissolved in dichloromethane (2×35 ml), giving after purification by column chromatography on silica gel with a mixture of dichloromethane/ethyl acetate (1/1) as eluent, **22a** (1.9 g, 89%) as a yellow solid. Mp=99 °C (lit.[39]=99–100 °C). ^{1}H NMR ($CDCl_3$): δ=9.33 (s, 1H); 8.02 (m, 2H); 7.81 (m, 2H); 1.25 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=157.8 (C); 143.0 (C); 142.2 (CH); 141.2 (C); 131.9 (CH); 131.6 (CH); 130.1 (CH); 129.9 (CH); 58.9 (C); 23.7 (CH_3). IR (KBr) (cm^{-1}): 2923–3056, 1488, 1363, 1171, 1051, 767, 626. Anal. calcd for $C_{12}H_{14}N_2OS$: C, 61.45; H, 5.97; N, 11.95; S, 13.70. Found: C, 61.32; H, 6.03; N, 12.02; S, 13.62%.

4.3.24. 2-*p*-Tolylsulfinylquinoxaline (22b). Oxidation of a solution of 2-*p*-tolylsulfanylquinoxaline **21b** (0.45 g, 1.78 mmol)), in dichloromethane (40 ml), was performed according to the general procedure with *m*-CPBA (2×0.22 g, 2×0.89 mmol) dissolved in dichloromethane (2×10 ml), giving after purification by column chromatography on silica gel with a mixture of dichloromethane/ethyl acetate (4/1) as eluent, **22b** (0.43 g, 90%) as a yellow solid. Mp=124 °C. ^{1}H NMR ($CDCl_3$): δ=9.33 (s, 1H); 8.02 (m, 2H); 7.72 (m, 2H); 7.67 (d, J=8.3 Hz, 2H); 7.19 (d, J=8.3 Hz, 2H); 2.24 (s, 3H). ^{13}C NMR ($CDCl_3$): δ=160.7 (C); 143.1 (C); 142.6 (C); 141.6 (C); 140.3 (C); 140.3 (CH); 131.8 (CH); 131.6 (CH); 130.6 (CH); 130.0 (CH); 129.8 (CH); 125.1 (CH); 21.8 (CH_3). IR (KBr) (cm^{-1}): 2921–3055, 1488, 1049, 812, 764, 507. Anal. calcd for $C_{15}H_{12}N_2OS$: C, 67.14; H, 4.51; N, 10.44. Found: C, 67.65; H, 4.53; N, 10.36%.

4.3.25. 2-Phenyl-4-*tert*-butylsulfanylquinazoline (23). Synthesis of **23** was performed according to the general procedure for preparation of sulfides with 2-methyl-2-propanethiol (3.5 ml, 31.16 mmol) in 70 ml of THF, *n*-butyllithium 2.5 M (12.5 ml, 31.16 mmol) and 4-chloro-2-phenylquinazoline **11** (5 g, 20.77 mmol) dissolved in 30 ml of THF. θ=66 °C, t=2 h. A purification by column chromatography on silica gel with dichloromethane as eluent gave **23** (5.36 g, 88%) as a pale yellow solid. Mp=88 °C. ^{1}H NMR ($CDCl_3$): δ=8.50 (d, J=8.1 Hz, 1H); 7.97 (d, J=8.3 Hz, 1H); 7.85 (d, J=8.7 Hz, 1H); 7.64 (dd, J=8.5 Hz, 6.7 Hz, 1H); 7.37 (m, 4H); 1.72 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=172.7 (C); 159.2 (C); 149.3 (C); 138.8 (C); 133.8 (CH); 130.8 (CH); 129.6 (CH); 129.0 (CH); 128.9 (CH); 126.9 (CH); 124.2 (CH); 123.3 (C); 49.3 (C); 30.7 (CH_3). IR (KBr) (cm^{-1}): 2912–3063, 1534, 1482, 1338, 1308, 1150, 990, 754, 707. Anal. calcd for $C_{18}H_{18}N_2S$: C, 73.43; H, 6.16; N, 9.51. Found: C, 73.48; H, 6.11; N, 9.36%.

4.3.26. 2-Phenyl-4-*tert*-butylsulfinylquinazoline (24). Oxidation of a solution of 2-phenyl-4-*tert*-butylsulfanylquinazoline **23** (0.51 g, 1.74 mmol)), in dichloromethane (40 ml), was performed according to the general procedure with *m*-CPBA (2×0.23 g, 2×0.87 mmol) dissolved in dichloromethane (2×10 ml), giving after purification by column chromatography on silica gel with a mixture of dichloromethane/ethyl acetate (9/1) as eluent, **24** (0.41 g, 77%) as a pale yellow solid. Mp=135 °C. ^{1}H NMR ($CDCl_3$): δ=9.09 (d, J=8.7 Hz, 1H); 8.53 (m, 2H); 8.06 (d, J=8.7 Hz, 1H); 7.86 (dd, J=7.7, 7.7 Hz, 1H); 7.53 (dd, J=7.7, 7.7 Hz); 7.45 (m, 3H); 1.33 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=170.5 (C); 158.9 (C); 152.4 (C); 137.2 (C); 135.1 (CH); 131.6 (CH); 129.8 (CH); 129.2 (CH); 129.0 (CH); 128.1 (CH); 125.2 (CH); 124.3 (C); 60.4 (C); 24.6 (CH_3). IR (KBr) (cm^{-1}): 2959–3197, 1666, 1602, 1482, 1297, 1056, 768, 693. Anal. calcd for $C_{18}H_{18}N_2OS$: C, 69.65; H5.84; N, 9.02. Found: C, 69.19; H, 5.84; N, 9.03%.

4.3.27. 1-Methoxy-4-*tert*-butylsulfanylphtalazine (25). Synthesis of **25** was performed according to the general procedure for preparation of sulfides with 2-methyl-2-propanethiol (1.28 ml, 11.31 mmol) in 50 ml of THF, *n*-butyllithium 2.5 M (4.52 ml, 11.31 mmol) and 1-chloro-4-methoxyphtalazine **12** (2 g, 10.28 mmol) dissolved in 15 ml of THF. θ=66 °C, t=2 h. A purification by column chromatography on silica gel with dichloromethane as eluent gave **25** (2.43 g, 95%) as a white solid. Mp=61 °C. ^{1}H NMR ($CDCl_3$): δ=8.14 (m, 2H, H_5+H_8); 7.75 (m, 2H, H_6+H_7); 4.22 (s, 3H, OCH_3); 1.63 (s, 9H, *t*Bu). ^{13}C NMR ($CDCl_3$): δ=159.7 (C_1); 156.5 (C_4); 132.3 (CH); 132.1 (CH); 129.10 (C_{10}); 125.0 (CH); 123.6 (CH); 120.0 (C_9); 55.2 (CH_3); 49.2 (C); 31.3 (CH_3). IR (KBr) (cm^{-1}): 2966, 1538, 1452, 1361, 1326, 966, 763, 656, 620. Anal. calcd for $C_{13}H_{16}N_2OS$: C, 62.87; H, 6.49; N, 11.28. Found: C, 62.91; H, 6.54; N, 11.56%.

4.3.28. 1-Methoxy-4-*tert*-butylsulfinylphtalazine (26). Oxidation of a solution of 1-methoxy-4-*tert*-butylsulfanylphtalazine **25** (2 g, 8.05 mmol)), in dichloromethane (150 ml), was performed according to the general procedure with *m*-CPBA (2×0.99 g, 2×4.03 mmol) dissolved in dichloromethane (2×30 ml), giving after purification by column chromatography on silica gel with a mixture of dichloromethane/ethyl acetate (3/7) as eluent, **26** (1.76 g, 83%) as a pale yellow solid. Mp=147 °C. ^{1}H NMR ($CDCl_3$): δ=9.17 (m, 1H, H_5); 8.20 (m, 1H, H_8); 7.82 (m, 2H, H_6+H_7); 4.25 (s, 3H, OCH_3); 1.30 (s, 9H, *t*Bu). ^{13}C NMR ($CDCl_3$): δ=161.8 (C); 156.5 (C); 132.9 (CH, 2C); 129.6 (C); 124.7 (CH); 123.8 (CH); 120.7 (C); 59.7 (C); 55.8 (CH_3); 24.6 (CH_3). IR (KBr) (cm^{-1}): 2866–3077, 1493, 1457, 1375, 1048, 704, 529.8. Anal. calcd for

$C_{13}H_{16}N_2O_2S$: C, 59.07; H, 6.10; N, 10.60. Found: C, 58.04; H, 5.57; N, 10.63%.

4.3.29. 2-Methylsulfinylquinoxaline (30). To a solution of thioquinoxalinol **27** (0.158 g, 0.97 mmol) dissolved in THF (5 ml) was added dropwise, at −78 °C, MeLi 1.5 M (0.71 ml, 1.07 mmol). After stirring the solution at −78 °C for 15 min *trans*-3-(1,1-dimethylethyl)-3-methyl-2-(phenylsulfonyl)oxaziridine **28** (0.259 g, 1.00 mmol) dissolved in THF (2 ml) was added dropwise over a 1 min period. The reaction mixture was stirred at −78 °C for 30 min and then treated with methyl iodide (0.19 ml, 3.03 mmol). The reaction mixture was then warmed to −20 °C over 1.5 h and then the cold bath was removed. After stirring for a further 1.5 h at room temperature, the reaction mixture was treated with saturated aqueous NH_4Cl solution (3 ml) and the product extracted with dichloromethane (3×20 ml). The combined organic extracts were washed with brine (3×10 ml), dried over magnesium sulfate, filtered an then evaporated. A 7/1 pentane/dichloromethane mixture was added to precipitate the benzenesulfonamide by-product from the crude mixture. After filtration and concentration under reduced pressure the crude product was purified by column chromatography on silica gel with ether petroleum/ethyl acetate (85/15) as eluent gave **30** (0.116 g, 62%) as a white solid. Mp=96 °C. (lit.[34] 102–103 °C). ^{1}H NMR ($CDCl_3$): δ=9.43 (s, 1H); 8.16 (m, 1H); 8.04 (m, 1H); 7.82 (m, 2H); 2.97 (s, 3H). ^{13}C NMR ($CDCl_3$): δ=160.5 (C); 143.2 (C); 141.5 (C); 140.8 (CH); 132.0 (CH); 131.9 (CH); 130.2 (CH); 129.7 (CH); 41.8 (CH_3). IR (KBr) (cm^{-1}): 2906–3043, 1495, 1364, 1054, 962, 775. Anal. calcd for $C_9H_8N_2OS$: C, 56.23; H, 4.19; N, 14.57. Found: C, 55.86; H, 4.07; N, 14.46%.

4.3.30. 2-*tert*-Butyl-4(3H)-quinazolinone (31). To 10 g (73 mmol) of anthranilic acid dissolved in 120 ml of pyridine was added, at 0 °C, 27 ml (219 mmol) of trimethylacetyl chloride. The mixture was then refluxing for 1 h. After cooling, 300 ml of water was added. The aqueous layer was extracted with dichloromethane (3×100 ml). The organic extract was evaporated and the residue was stirred overnight in 200 ml of ammonia (30%). After evaporation of ammonia, 200 ml of a solution of aqueous sodium hydroxide (5%) was added and the solution was refluxing for 1 h. After cooling and acidification to pH=4 with HCl (1M), the precipitate was collected and washed with water to give **31** (14.33 g, 97%) as a white solid. Mp=185 °C. ^{1}H NMR (DMSO-d_6): δ=11.98 (s, 1H); 8.16 (dd, J=7.9, 1.1 Hz, 1H); 7.85 (m, 1H); 7.69 (d, J=7.9 Hz, 1H); 7.55 (m, 1H); 1.42 (s, 9H). ^{13}C NMR (DMSO-d_6): δ=163.0 (C); 162.7 (C); 148.6 (C); 134.6 (CH); 127.6 (CH); 126.5 (CH); 125.9 (CH); 121.0 (C); 37.6 (C); 28.1 (CH_3). IR (KBr) (cm^{-1}): 2873–3179, 1666, 1610, 1470, 1165, 972, 770. Anal. calcd for $C_{12}H_{14}N_2O$: C, 71.26; H, 6.98; N, 13.85. Found: C, 71.24; H, 6.87; N, 13.78%.

4.3.31. 5-Phenylsulfanyl-2-*tert*-butyl-4(3H)-quinazolinone (32). A stirred solution of 2-*tert*-butyl-4(3H)-quinazolinone **31** (10 g, 49 mmol) and TMEDA (30 ml, 199 mmol), dissolved in 100 ml of tetrahydrofuran and under an atmosphere of dry nitrogen, was cooled to −78 °C. *sec*-butyllithium 1.3 M (153 ml, 199 mmol) was added dropwise and the mixture was warmed to 0 °C and kept at this temperature for 1 h. The solution was cooled to −78 °C and a solution of phenyl disulfide (43.2 g, 198 mmol) in 50 ml of tetrahydrofuran was added and the mixture was stirred for 1 h at −78 °C. Hydrolysis was then carried out at −78 °C using a mixture of water (20 ml) and ethanol (20 ml). The solution was gently warmed to room temperature and the solvent was removed under reduced pressure. The residue was extracted with dichloromethane (4×70 ml). The organic layer was dried over magnesium sulfate and evaporated. The residue was washed with dichloromethane (10 ml) and collected by filtration. A second wash with 10 ml of dichloromethane gave **32** after filtration (5.73 g, 37%) as a white solid. Mp>265 °C. ^{1}H NMR ($CDCl_3$): δ=10.85 (s, 1H, NH); 7.57 (m, 2H); 7.42 (m, 3H); 7.29 (m, 2H); 6.51 (m, 1H); 1.42 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=164.2 (C); 162.5 (C); 151.3 (C); 144.2 (C); 136.7 (CH); 133.9 (CH); 132.6 (C); 130.4 (CH); 129.9 (CH); 123.7 (CH); 123.3 (CH); 37.7 (C); 28.7 (CH_3). IR (KBr) (cm^{-1}): 2929–3166; 1648; 1620; 1585; 1549; 1455, 1304; 949. Anal. calcd for $C_{18}H_{18}N_2OS$: C, 69.65; H, 5.84; N, 9.02; S, 10.33. Found: C, 69.37; H, 5.93; N, 8.87; S, 10.58%.

4.3.32. 4-Chloro-5-phenylsulfanyl-2-*tert*-butylquinazoline (33). A mixture of 5-phenylsulfanyl-2-*tert*-butyl-4(3H)-quinazolinone **32** (3.9 g, 12.56 mmol), phosphorus oxychloride (1.95 ml, 20.92 mmol) pyridine (0.98 ml, 12.02 mmol) and chlorobenzene (100 ml) was heated at 130 °C for 5 h. after cooling to room temperature, 50 ml of water was added then the reaction mixture was neutralized with a saturated aqueous solution of potassium carbonate. The aqueous layer was extracted with dichloromethane. The organic layer was washed with 100 ml of an aqueous solution of sodium hydroxide (2 M), dried over magnesium sulfate and evaporated. A purification by column chromatography on neutral alumina with ether petroleum/ethyl acetate (95/5) as eluent gave **33** (3.89 g, 94%) as a yellow solid. Mp=73 °C. ^{1}H NMR ($CDCl_3$): δ=7.62 (d, J=8.3 Hz, 1H); 7.40 (m, 3H); 7.33 (m, 3H); 6.91 (d, J=7.9 Hz, 1H); 1.38 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=172.5 (C); 160.5 (C); 154.3 (C); 139.2 (C); 135.3 (CH); 133.4 (CH); 133.3 (C); 130.5 (CH); 129.6 (CH); 128.2 (CH); 126.7 (CH); 120.8 (C); 29.6 (C); 29.7 (CH_3). IR (KBr) (cm^{-1}): 2921–3063, 1568, 1545, 1270, 1120, 881, 823, 755. Anal. calcd for $C_{18}H_{17}ClN_2S$: C,65.74; H, 5.21; N, 8.52; S, 9.75. Found: C, 65.57; H, 5.57; N, 8.28; S, 10.22%.

4.3.33. 5-Phenylsulfanyl-2-*tert*-butyl-4-toluene-*p*-sulphonylhydrazinoquinazoline (34). To 4-chloro-5-phenylsulfanyl-2-*tert*-butylquinazoline **33** (12.4 g, 34.7 mmol) dissolved in 500 ml of tetrahydrofuran was added toluene-*p*-sulphonylhydrazide (17.56 g, 94.26 mmol). The reaction mixture was refluxed. The pale yellow crystals of 5-phenylsulfanyl-2-*tert*-butyl-4-toluene-*p*-sulphonylhydrazinoquinazoline **34** formed were collected after 7 days (9.30 g, 56%). Mp=263 °C. ^{1}H NMR (DMSO-d_6): δ=10.65 (s, 1H, NH); 9.59 (s, 1H, NH); 8.00 (d, J=8.3 Hz, 2H); 7.59 (m, 5H); 7.40 (d, J=7.9 Hz, 2H); 7.19 (dd, J=7.9, 7.9 Hz, 1H); 7.08 (d, J=8.3 Hz, 1H); 6.36 (d, J=7.5 Hz, 1H); 2.39 (s, 3H); 1.37 (s, 9H). ^{13}C NMR (DMSO-d_6): δ=164.2 (C); 146.6 (C); 143.3 (C); 139.7 (C); 139.2 (C); 136.6 (C); 135.9 (CH)); 133.4 (C); 130.5 (CH); 130.3 (CH); 129.7 (CH); 129.5 (CH); 128.2 (CH); 122.2 (CH); 112.6 (C); 112.0

(CH); 37.5 (C); 28.0 (CH_3); 21.3 (CH_3). IR (KBr) (cm^{-1}): 3362, 3199, 1606, 1504, 1162, 706, 689, 560. Anal. calcd for $C_{25}H_{26}N_4O_2S_2$: C, 62.74; H, 5.47; N, 11.71; S, 13.40. Found: C, 62.52; H, 5.22; N, 11.76; S, 13.32%.

4.3.34. 5-Phenylsulfanyl-2-*tert*-butylquinazoline (35). 5-Phenylsulfanyl-2-*tert*-butyl-4-toluene-*p*-sulphonylhydrazinoquinazoline **34** (2.36 g, 4.9 mmol) was added to a stirred solution of sodium carbonate (3.12 g, 29.4 mmol) in 60 ml of water and warmed at 180 °C for 3 h under a pressure of 7 bars. The aqueous layer was extracted with dichloromethane and the organic layer was dried over magnesium sulfate and evaporated. A purification by column chromatography on silica gel with ether petroleum/dichloromethane (1/1) as eluent gave **35** (1.2 g, 83%) as a pale yellow solid. Mp=107 °C. ^{1}H NMR ($CDCl_3$): δ=9.76 (s, 1H); 7.85 (d, J=8.3 Hz, 1H); 7.67 (dd, J=7.9, 7.4 Hz, 1H); 7.47 (dd, J=7.2, 1.1 Hz, 1H); 7.21 (m, 5H); 1.43 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=174.7 (C); 155.5 (CH); 151.1 (C); 144.7 (C); 142.3 (C); 133.3 (CH); 132.6 (CH); 132.0 (CH); 130.1 (CH); 125.7 (CH); 124.8 (CH); 119.6 (C); 40.1 (C); 29.9 (CH_3). IR (KBr) (cm^{-1}): 2864–3058; 1602; 1574, 1552, 1480; 1112; 833; 745; 717. Anal. calcd for $C_{18}H_{18}N_2S$: C, 73.43; H, 6.16; N, 9.51. Found: C, 73.47; H, 6.21; N, 9.29%.

4.3.35. 5-Phenylsulfinyl-2-*tert*-butylquinazoline (36). Oxidation of a solution of 5-phenylsulfanyl-2-*tert*-butylquinazoline **35** (3.4 g, 11.55 mmol)), in dichloromethane (300 ml), was performed according to the general procedure with *m*-CPBA (2×1.41 g, 2×5.78 mmol) dissolved in dichloromethane (2×15 ml), giving after purification by column chromatography on silica gel with a mixture of ether petroleum/ethyl acetate (7/3) as eluent, **36** (3.22 g, 90%) as a pale yellow solid. Mp=137 °C. ^{1}H NMR ($CDCl_3$): δ=9.77 (s, 1H, H_4); 8.16 (d, J_{6-7}=7.2 Hz, 1H, H_6); 8.01 (d, J_{8-7}=8.7 Hz, 1H, H_8); 7.90 (dd, J_{7-6}=7.3 Hz, J_{7-8}= 8.5 Hz, 1H, H_7); 7.63 (m, 2H); 7.63 (m, 3H); 1.38 (s, 9H). ^{13}C NMR ($CDCl_3$): δ=174.7 (C_2); 155.5 (C_4); 151.1 (C_9); 144.8 (C); 142.3 (C_5); 133.3 (C_7); 132.6 (C_8); 131.9 (CH); 130.1 (CH); 125.7 (CH); 124.8 (C_6); 119.6 (C_{10}); 40.1 (C); 29.9 (CH_3). IR (KBr) (cm^{-1}): 2864–3063, 1577, 1552, 1438, 1057, 833, 693. Anal. calcd for $C_{13}H_{16}N_2O_2S$: C, 69.65; H, 6.26; N, 9.02. Found: C, 69.97; H, 6.14; N, 8.89%.

4.3.36. 2-*tert*-Butyl-5-*tert*-butylsulfanylquinazolin-4-one (37) and 2-*tert*-butyl-8-*tert*-butylsulfanylquinazolin-4-one (38). A stirred solution of 2-*tert*-butyl-4(3H)-quinazolinone **31** (5 g, 25 mmol) and TMEDA (15 ml, 100 mmol), dissolved in 50 ml of tetrahydrofuran and under an atmosphere of dry nitrogen, was cooled to −78 °C. *sec*-Butyllithium 1.3 M (77 ml, 100 mmol) was added dropwise and the mixture was warmed to 0 °C and kept at this temperature for 1 h. *tert*-Butyl disulfide (20 ml, 100 mmol) was added and the mixture was stirred for 3 h at 0 °C. Hydrolysis was then carried out at 0 °C with water (30 ml). The solution was gently warmed to room temperature and the solvent was removed under reduced pression. The residue was extracted with dichloromethane. The organic layer was dried over magnesium sulfate and evaporated. A purification by column chromatography on silica gel with dichloromethane/diethyl ether (9/1) as eluent gave **37** in a first fraction (2.02 g, 30%) as a white solid. Mp=200 °C. ^{1}H NMR ($CDCl_3$): δ=11.59 (s, 1H); 7.69 (m, 3H); 1.65 (s, 9H, S-*t*Bu); 1.64 (s, 9H, *t*Bu). ^{13}C NMR ($CDCl_3$): δ=163.9 (C_4); 162.7 (C_2); 152.0 (C_9); 140.0 (C_5); 133.1 (CH); 129.8 (CH); 125.7 (CH); 120.3 (C_{10}); 46.8 (C, S-*t*Bu); 37.7 (C, *t*Bu); 31.3 (CH_3, S-*t*Bu); 28.7 (CH_3, *t*Bu). IR (KBr) (cm^{-1}): 2956–3170, 1656, 1620, 1585, 1454, 1296, 980. Anal. calcd for $C_{16}H_{22}N_2OS$: C, 66.17; H, 7.63; N, 9.65. Found: C, 65.74; H, 7.61; N, 9.46%.

A second fraction gave **38** (1.27 g, 18%) as a white solid. Mp=165 °C. ^{1}H NMR ($CDCl_3$): δ=11.10 (s, 1H); 8.30 (d, J=7.9 Hz, 1H, H_5); 8.03 (d, J=7.2 Hz, 1H, H_7); 7.39 (dd, J=7.7, 7.7 Hz, 1H, H_6); 1.50 (s, 9H, *t*Bu); 1.33 (s, 9H, S-*t*Bu). ^{13}C NMR ($CDCl_3$): δ=164.4 (C_4); 162.0 (C_2); 151.6 (C_9); 144.9 (C_7); 132.7 (C_8); 127.7 (C_5); 126.1 (C_6); 121.9 (C_{10}); 47.8 (C, S-*t*Bu); 38.4 (C, *t*Bu); 31.7 (CH_3, S-*t*Bu); 28.7 (CH_3, *t*Bu). IR (KBr) (cm^{-1}): 2964–3176, 1665, 1614, 1590, 1422, 986, 784, 776. Anal. calcd for $C_{16}H_{22}N_2OS$: C, 66.17; H, 7.63; N, 9.65. Found: C, 65.78; H, 7.37; N, 9.46%.

4.3.37. 2-*tert*-Butyl-5-*tert*-butylsulfinylquinazolin-4-one (39). Oxidation of a solution of 2-*tert*-butyl-5-*tert*-butylsulfanylquinazolin-4-one **37** (0.15 g, 0.52 mmol) in dichloromethane (10 ml), was performed according to the general procedure with *m*-CPBA (2×64 mg, 2×0.26 mmol) dissolved in dichloromethane (2×5 ml), giving after purification by column chromatography on silica gel with a mixture of ethyl acetate/dichloromethane (8/2) as eluent, **39** (64 mg, 40%) as a pale yellow solid. Mp>265 °C. ^{1}H NMR ($CDCl_3$): δ=10.9 (s, 1H, NH); 8.11 (dd, J_{6-7}=7.4 Hz, J_{6-8}=1.3 Hz, 1H, H_6); 7.8 (m, 2H, H_7+H_8); 1.44 (s, 9H, *t*Bu); 1.15 (s, 9H, S(O)-*t*Bu). ^{13}C NMR ($CDCl_3$): δ=16.7 (C); 163.2 (C); 150.7 (C); 143.4 (C); 134.0 (CH); 131.1 (CH); 125.7 (CH); 119.3 (C); 59.8 (C); 38.1 (C); 28.8 (CH_3); 23.7 (CH_3). IR (KBr) (cm^{-1}): 2976–3172, 1658, 1613, 1592, 1456, 1042, 974, 823. HRMS (DCI^+) calcd for (MH^+) $C_{16}H_{23}N_2O_2S$: *m*/*z* 307.1480. Found: 307.1476.

4.3.38. 2-*tert*-Butyl-8-*tert*-butylsulfinylquinazolin-4-one (40). Oxidation of a solution of 2-*tert*-butyl-8-*tert*-butylsulfanylquinazolin-4-one **38** (0.7 g, 2.41 mmol), in dichloromethane (40 ml), was performed according to the general procedure with *m*-CPBA (2×0.3 g, 2×1.2 mmol) dissolved in dichloromethane (2×10 ml), giving after purification by column chromatography on silica gel with a mixture of ethyl acetate/dichloromethane (8/2) as eluent, **40** (0.7 g, 95%) as a pale yellow solid. Mp=162 °C. ^{1}H NMR ($CDCl_3$): δ=11.76 (s, 1H, NH); 8.32 (d, J_{5-6}=7.5 Hz, 1H, H_5); 8.22 (d, J_{7-6}=7.1 Hz, 1H, H_7); 7.57 (dd, J=7.7, 7.7 Hz, 1H, H_6); 1.42 (s, 9H, *t*Bu); 1.17 (s, 9H, S(O)-*t*Bu). ^{13}C NMR ($CDCl_3$): δ=163.9 (C_4); 163.3 (C_2); 147.4 (C_9); 138.9 (C_8); 133.6 (C_7); 129.3 (C_5); 126.5 (C_6); 121.0 (C_{10}); 58.7 (C, S(O)-*t*Bu); 38.4 (C, $_t$Bu); 28.6 (CH_3, *t*Bu); 23.9 (CH_3, S(O)-*t*Bu). IR (KBr) (cm^{-1}): 2960–3183, 1671, 1602, 1427, 1034, 782. Anal. calcd for $C_{16}H_{22}N_2O_2S$: C, 62.72; H, 7.24; N, 9.14. Found: C, 62.55; H, 6.84; N, 8.58%.

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