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# Novel routes to triazino[5,6-b]indole and indolo[2,3-b]quinoxaline derivatives

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The reaction of isatin with *o*-phenylenediamine afforded 6*H*-indolo[2,3-b]quinoxaline**.** While the reaction of isatin with semicarbazide hydrochloride afforded 2-(2-oxoindolin-3-ylidene)hydrazine carboxamide, which cyclizes to 2*H*-[1,2,4]triazino[5,6-b]indol-3(5*H*)-one. The 1,2,4-triazino[5,6-b]indolo derivatives were synthesized starting from the latter compound**.** 6*H*-Indolo[2,3-b]quinoxaline reacted with chloroacetone to afford 1-(6*H*-indolo[2,3-b]quinoxalin-6-yl)propan-2-one, which coupled readily with benzenediazonium chloride to yield the aryl hydrazone derivative from which, the indolo[2,3-b]quinoxalinyl thieno[3,4-d]pyridazine and the indolo[2,3-b]quinoxalinyl pyridazine derivatives could be prepared. The indolo[2,3-b]quinoxalinyl pyridine derivative was prepared from the enaminone 4-(N,N-dimethylamino)-3-(6*H*-indolo[2,3-b]quinoxalin-6-yl)-2-butanone. Chemical and spectroscopic evidences for the new compounds are described.

**Key words:** enaminone, isatin, indolo[2,3-b]quinoxaline, *o*-phenylenediamine, triazino[5,6-b]indole.

## INTRODUCTION

Polynuclear condensed heterocyclic compounds or polynuclear compounds having another noncondensed heterocycle in their molecules are noted for the significant biological activity. Their cancerostatic and virostatic effects are based especially on intercalation into the double helix of DNA or inhibition of topoisomerase [1, 2]. Therefore, indole and quinoxaline derivatives display diverse pharmacological activities [3−5]. Quinoxaline derivatives have been synthesized by many research groups [4, 6−8]. In continuation of our work [9−11] the present study focuses on the synthesis of new indoloquinoxaline (**1**) and indolotriazine (**3**) derivatives. The results of the investigation on the reactivity of **1** and **3** towards nitrogen and carbon electrophiles are reported.

## RESULTS AND DISCUSSION

The reaction of isatin with *o*-phenylenediamine in a solution of sodium bicarbonate afforded in good yield the indoloquinoxaline **1** (Scheme 1). The structure of the isolated product was confirmed on the basis of elemental analysis and spectral data.

However treatment of isatin with semicarbazide hydrochloride yielded the hydrazonocarboxamide derivative **2**, which cyclized to the triazino[5,6-b]indole **3** by boiling in acetic acid (Scheme 1).

The condensation of compound **3** with malononitrile in dimethylformamide (DMF) solution containing triethylamine yielded the triazinoindolyl malononitrile derivative **4**. The latter reacted with urea and/or thiourea in sodium ethoxide to afford the triazinoindolyl pyrimidine derivatives **5a**, **b** (Scheme 1).

Compound **6** could be easily prepared via reacting **1** with chloroacetone in refluxing toluene and in the presence of equivalent amount of triethylamine. The $^1$H NMR spectrum of compound **6** displayed two singlets, one at $\delta$ = 2.15 ppm for the $CH_3$ protons of the acetyl group, and the second at $\delta$ = 4.70 ppm assigned for the methylene protons.

Coupling **6** with benzenediazonium chloride in ethanolic sodium acetate solution produces the corresponding aryl hydrazone **7** in good yield. Condensation of **7** with phenylhydrazine afforded diphenylhydrazone derivative **8** that has already been obtained by an alternative method, via coupling the phenylhydrazone derivative **10** with benzenediazonium chloride. Compound **10** could be prepared *via* condensing **6** with phenylhydrazine in refluxing acetic acid. Reaction of compound **6** with benzylidenemalononitrile yielded the addition product **9** (Scheme 1). Compound **7** condensed readily with malononitrile to yield the indolo[2,3-b]quinoxalinyl pyridazine derivative **13** (Scheme 2). Compound **13** reacted with sulphur in refluxing DMF in the presence of piperidine to yield the indolo[2,3-b]quinoxalinyl thieno pyridazine derivative **14.** Compound **7** also condensed with dimethylformamide dimethylacetal (DMFDMA) in refluxing toluene to afford the indolo[2,3-b]quinoxalinyl pyridazine

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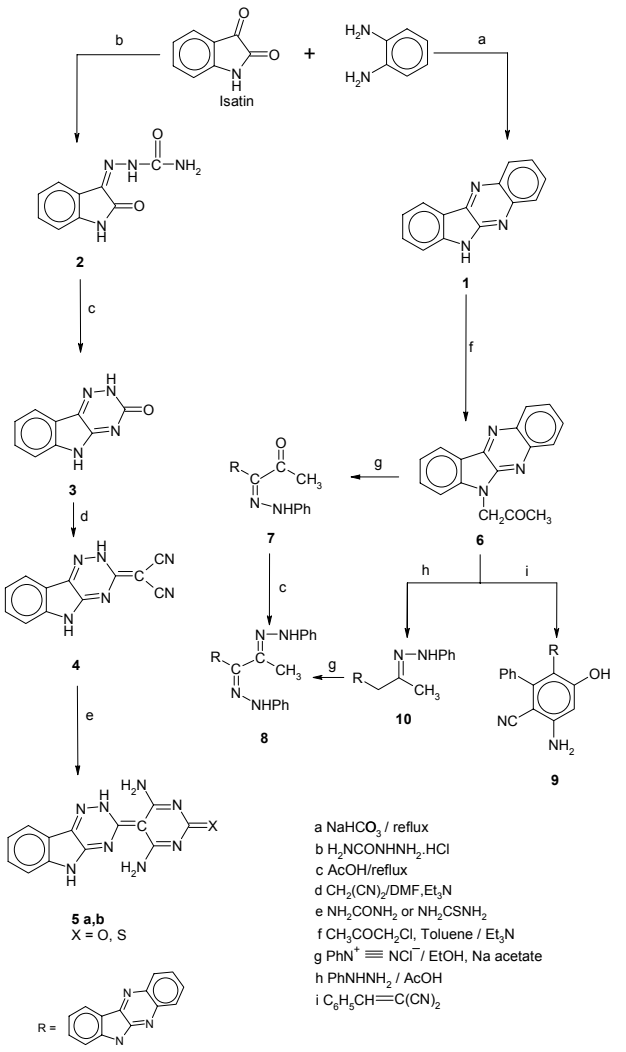
derivative **16** (Scheme 2).




Scheme 1.

Treatment of **16** with malononitrile afforded the ylidenomalononitrile derivative **17**. Further on, the pyrimidine derivatives **18a**, **b** were obtained by refluxing **17** in sodium ethoxide with urea or thiourea respectively (Scheme 2).

Treatment of **6** with DMFDMA in dry xylene at reflux temperature afforded the enaminone **19** in a good yield (Scheme 3). The structure of the isolated product revealed a singlet at δ = 2.30 ppm indicating the presence of six protons of $N(CH_3)_2$.

The reaction of **19** with malononitrile in refluxing ethanol and in the presence of piperidine yielded a product that could be formulated as **23**. The formation of the latter is assumed to proceed via initial addition of the active methylene reagent across the double bond in **19** producing the intermediate Michael's adduct **20** that then cyclizes into **21,** which undergoes Dimroth's type of rearrangement and aromatizes *via* loss of a water molecule and dimethylamine to yield the final isolated product **23** (Scheme 3). The $^1$H NMR spectrum of compound **23** showed a resonance at $\delta_H$ = 1.99 ppm corresponding to methyl protons and a signal at $\delta_H$ = 8.433 ppm assigned to pyridinyl 4-*H*. Alternatively, initial condensation of **19** with malononitrile could yield the initial condensation product **24** that is further hydrolysed into **25** and subsequently cyclizes to **26.** The product failed to react with sulphur to yield a condensed thiophene, as it is characteristic of azines with vicinal methyl and carbonitrile substituents [12], so structure **26** was ruled out and the product was assigned to be **23**. Compound **23** reacts with hydrazine hydrate in refluxing ethanolic solution to give the pyrazolo pyridyl indolo quinoxaline derivative **27** (Scheme 3).

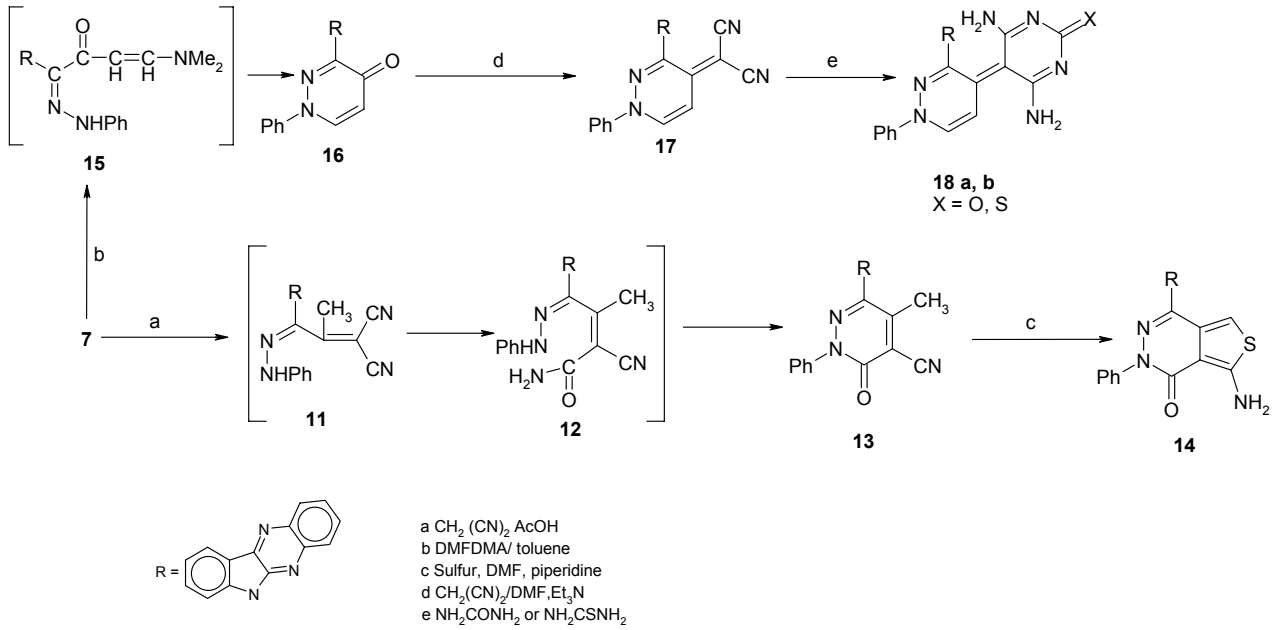
## EXPERIMENTAL

All melting points are uncorrected. The IR spectra (KBr) were recorded on a Pye Unicam SP-100 spectrophotometer. $^1$H NMR spectra (DMSO-$d_6$, as a solvent) were obtained on a Varian Gemini 200 MHz spectrometer, using TMS as internal standard. Chemical shifts in δ (ppm) values; Mass spectra: AEI MS 30 mass spectrometer operating at 70 eV; microanalytical data were obtained from Microanalytical Data Unit at Cairo University.

*6H-Indolo[2,3-b]quinoxaline* (**1**). Isatin (1.71 g, 11.6 mmol) was dissolved in refluxing aqueous sodium bicarbonate solution (2.38 g, 28.3 mmol in 160 ml water). *o*-Phenylenediamine (1.44 g, 13.29 mmol) was added and the mixture was refluxed for 20 min. After cooling down to the room temperature the solution was acidified with acetic acid and left to stay overnight. The precipitate was filtered, washed with water and dried in air.

Yield 90%; yellow crystals from ethanol; m.p. 283°C; IR (KBr) ν ($cm^{-1}$): 1615 (C=N), 3448 (NH), 3065 (CH aromatic); $^1$H NMR (DMSO-$d_6$) δ: 11.98 (s, 1H, NH), 7.31−8.33 (m, 8H, $2C_6H_4$); MS: m/z = 219 [$M^+$]; Anal. Calcd. for $C_{14}H_9N_3$: C, 76.69; H, 4.14; N, 19.16%. Found: C, 76.81; H, 4.03; N, 19.28%.

*2-(2-Oxoindolin-3-ylidene)hydrazinecarboxamide* (**2**). Isatin (0.74 g, 5 mmol) was dissolved in a refluxing solution of sodium bicarbonate (1.03 g, 12.3 mmol) in water (150 ml). Semicarbazide hydrochloride (0.70 g, 6.3 mmol) was added to this solution and the mixture was left to stay at room temperature for two days. The mixture was filtered and the filtrate was acidified with acetic acid. After two days, the precipitated solid was filtered, washed with water and dried.




Scheme 2.

Yield 95%; yellow crystals from water; m.p. 262°C; IRS (KBr) ν ($cm^{-1}$): 1700, 1690 (C=O), 1612 (C=N), 3310, 3330, 3468 (NH, $NH_2$); $^1$H NMR (DMSO-$d_6$) δ: 9.5 (br, 2H, $NH_2$), 10.58, 12.0 (2br s, 2H, 2NH), 6.91−7.59 (m, 4H, $C_6H_4$); MS: m/z = 204 [$M^+$]; Anal. Calcd. for $C_9H_8N_4O_2$: C, 52.94; H, 3.95; N, 27.44%. Found: C, 52.89, H, 3.99; N, 27.51%.

*2H-[1,2,4]Triazino[5,6-b]indol-3(5H)-one* (**3**). Compound **2** (1.22 g, 6 mmol) was refluxed in acetic acid (100 ml) for 2 h. After cooling, the solid was filtered, washed with water and dried.

Yield 93%; yellow crystals from acetic acid; m.p. 280°C; IRS (KBr) ν ($cm^{-1}$): 3336 (NH), 1698 (C=O), 1634 (C=N); $^1$H NMR (DMSO-$d_6$) δ: 7.37−8.01 (m, 4H, $C_6H_4$), 11.79, 13.47 (2br s, 2H, 2NH); MS: m/z = 186 [$M^+$]; Anal. Calcd. for $C_9H_6N_4O$: C, 58.06; H, 3.25; N, 30.09%. Found: C, 58.11; H, 3.28; N, 30.28%.

*General procedure for the synthesis of compounds* (**4**) *and* (**17**)

To each solution of **3** (1.9 g, 10 mmol) or **16** (3.9 g, 10 mmol) in DMF (40 ml), containing triethylamine (1 ml), malononitrile (0.66 g, 1 mmol) was added. The reaction mixture was heated under reflux for 3 h. The solid product formed upon dilution with water, containing a few drops of HCl, was collected by filtration.

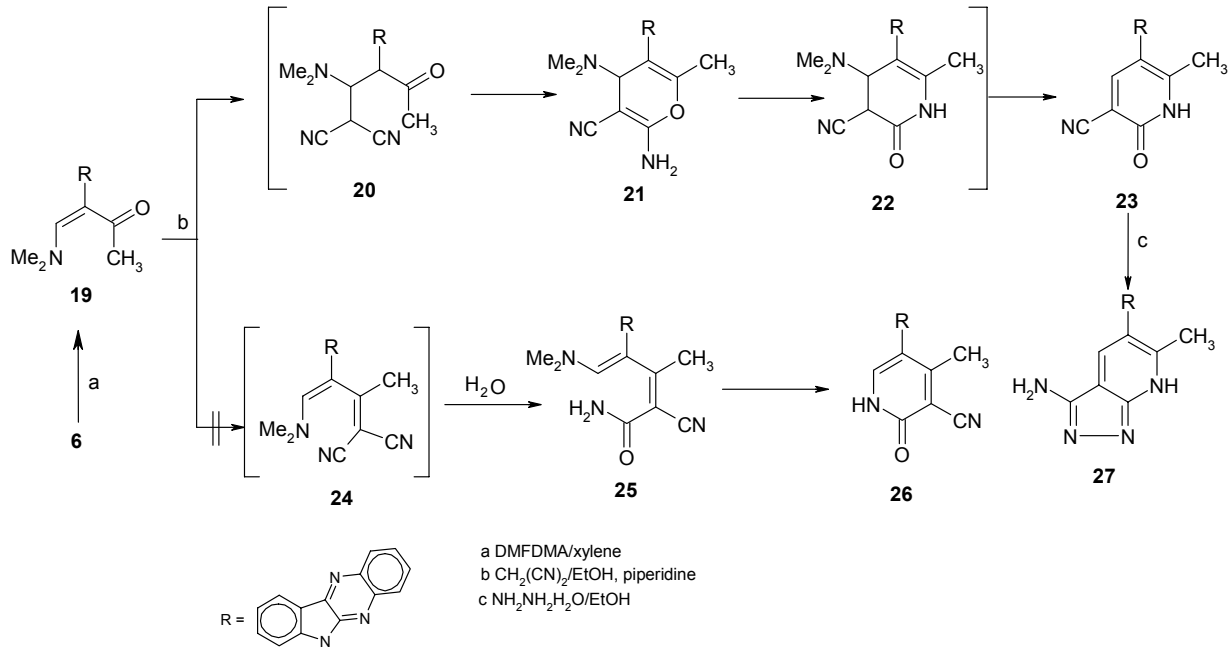
*2-(2H-[1,2,4]Triazino[5,6-b]indol-3(5H)-ylidene) malononitrile* (**4**). Yield 90%; yellow crystals from dioxane; m.p. 292°C; IRS (KBr) ν ($cm^{-1}$): 3330 (NH), 2220, 2225 (2CN), 1630 (C=C), 1650 (C=N), $^1$H NMR (DMSO-$d_6$) δ: 7.21−7.55 (m, 4H, $C_6H_4$), 12.3, 13.0 (2br s, 2H, 2NH); MS: m/z = 234 [$M^+$]; Anal. Calcd. for $C_{12}H_6N_6$: C, 61.54; H, 2.58; N, 35.88%. Found: C, 61.46; H, 2.49; N, 35.98%.

*1-Phenyl-3-(6H-indolo[2,3-b]quinoxalin-6-yl)-4-(ylidene-2-malononitrile)pyridazine* (**17**). Yield 78% pale yellow crystals from dioxane; m.p. 320°C; IRS (KBr) ν ($cm^{-1}$): 2220, 2225 (2CN), 1620 (C=N), 1600 (C=C); $^1$H NMR (DMSO-$d_6$) δ: 7.91, 6.80 (2d, 2H, pyridazinyl 6-H, 5-H), 7.30−7.88 (m, 13H, $2C_6H_4$, $C_6H_5$); MS: m/z = 437 [$M^+$]; Anal. Calcd. for $C_{27}H_{15}N_7$: C, 74.13; H, 3.46; N, 22.41%. Found: C, 73.18; H, 3.44; N, 22.58%.

*General procedure for the synthesis of compounds* (**5a**, **b**) *and* (**18a**, **b**)

Urea (0.6 g, 10 mmol) or thiourea (0.8 g, 10 mmol) was added to each solution of **4** (2.3 g, 10 mmol) or **17** (4.4 g, 10 mmol) in sodium ethoxide (10 mmol) [prepared by adding sodium metal (0.23 g, 10 mmol) to absolute ethanol (40 ml)] and the mixture was heated under reflux on a steam bath for 4−6 h. The solid product formed upon pouring onto ice water containing a few drops of HCl (until pH 6) was collected by filtration.

*5-(2H-[1,2,4]Triazino[5,6-b]indolo-3(5H)-ylidene)-4,6-diaminopyrimidine-2-one* (**5a**). Yield 85%; orange crystals from dioxane; m.p. > 360°C; IRS (KBr) ν ($cm^{-1}$): 3430, 3330, 3310 (NH, $NH_2$), 1650 (C=N), 1630 (C=C), 1690 (CO); $^1$H NMR (DMSO-$d_6$) δ: 7.24−7.50 (m, 4H, $C_6H_4$), 12.3, 13.0 (2br s, 2H, 2NH), 2.5, 3.4 (2s, 4H, $2NH_2$), MS: m/z = 294 [$M^+$]; Anal. Calcd. for $C_{13}H_{10}N_8O$: C, 53.06; H, 3.42; N, 38.0%. Found: C, 53.10; H, 3.40; N, 38.25%.




Scheme 3.

*5-(2H-[1,2,4]Triazino[5,6-b]indolo-3(5H)-ylidene)-4,6-diaminopyrimidine-2-thione* (**5b**). Yield 85%; yellow solid from DMF; m.p. > 360°C; IRS (KBr) ν ($cm^{-1}$): 1200 (C=S), 3440, 3330, 3310 (NH, $NH_2$), 1650 (C=N), 1630 (C=C); $^1$H NMR (DMSO-$d_6$) δ: 7.23−7.45 (m, 4H, $C_6H_4$), 12.3, 13.0 (2br s, 2H, 2NH), 2.45, 3.38 (2s, 4H, $2NH_2$); MS: m/z = 310 [$M^+$]; Anal. Calcd. for $C_{13}H_{10}N_8S$: C, 50.31; H, 3.25; N, 36.11; S, 10.33%. Found: C, 50.33; H, 3.30; N, 36.28; S, 10.38%.

*5-[3-(6H-Indolo[2,3-b]quinoxalin-6-yl)-4-ylidene-1-phenylpyridazine]-4,6-diaminopyrimidine-2-one* (**18a**). Yield 68%; yellow crystals from ethanol/dioxane; m.p. > 360°C; IRS (KBr) ν ($cm^{-1}$): 1690 (CO), 3430, 3310 ($NH_2$), 1650 (C=N), 1635 (C=C); $^1$H NMR (DMSO-$d_6$) δ: 7.91, 6.8 (2d, 2H, pyridazinyl 6-H, 5-H), 2.45, 3.38 (2s, 4H, $2NH_2$), 7.31–7.89 (m, 13H, $C_6H_5$, $2C_6H_4$); MS: m/z = 497 [$M^+$]; Anal. Calcd. for $C_{28}H_{19}N_9O$: C, 67.59; H, 3.85; N, 25.34%. Found: C, 67.68; H, 3.84; N, 25.38%.

*5-[3-(6H-Indolo[2,3-b]quinoxalin-6-yl)-4-ylidene-1-phenylpyridazine]-4,6-diaminopyrimidine-2-thione* (**18b**). Yield 65%; pale yellow solid from ethanol/dioxane; m.p. > 360°C; IRS (KBr) ν ($cm^{-1}$): 1200 (C=S), 3430, 3310 ($NH_2$), 1650 (C=N), 1635 (C=C); $^1$H NMR (DMSO-$d_6$) δ: 7.92, 6.8 (2d, 2H, pyridazinyl 6-H, 5-H), 2.40, 3.39 (2s, 4H, $2NH_2$), 7.32−7.86 (m, 13H, $C_6H_5$, $2C_6H_4$); MS: m/z = 513 [$M^+$]; Anal. Calcd. for $C_{28}H_{19}N_9S$: C, 65.48; H, 3.73; N, 24.55; S, 6.24%. Found: C, 65.51; H, 3.75; N, 24.61; S, 6.28%.

*1-(6H-Indolo[2,3-b}quinoxalin-6-yl]propan-2-one* (**6**). A solution of **1** (2.2 g, 10 mmol) in dry toluene (30 ml) was treated with chloroacetone (0.93 g, 10 mmol) in the presence of triethylamine (1 ml). The reaction mixture was refluxed for 7 h. The solvent was evaporated under vacuum and the solid product, so formed, was collected by filtration.

Yield 85%; pale yellow crystals from benzene; m.p. 295°C; IRS (KBr) ν ($cm^{-1}$): 2960, 2840 ($CH_3$, $CH_2$), 1680 (CO); $^1$H NMR (DMSO-$d_6$) δ: 2.15 (s, 3H, $CH_3$), 4.70 (s, 2H, $CH_2$), 7.4−8.35 (m, 8H, $2C_6H_4$); MS: m/z = 275 [$M^+$]; Anal. Calcd. for $C_{17}H_{13}N_3O$: C, 74.17; H, 4.76; N, 15.26%. Found: C, 74.20; H, 4.77; N, 15.47%.

*1-(6H-Indolo[2,3-b]quinoxalin-6-yl)-1-(2-phenylhydrazono)propan-2-one* (**7**). A cold solution of benzenediazonium chloride (10 mmol) [prepared by the addition of sodium nitrite (0.7 g in 5 ml water) to a cold solution (0.5°C) of aniline (0.93 g, 10 mmol) containing the appropriate amount of hydrochloric acid], was added to a solution of **6** (2.75 g, 10 mmol) in ethanol (50 ml) containing sodium acetate (3 g). The reaction mixture was stirred at room temperature for 2 h, and left to stay overnight in the refrigerator. The solid product, so formed, was collected by filtration.

Yield 83%; orange crystals from ethanol; m.p. 330°C; IRS (KBr) ν ($cm^{-1}$): 3215 (NH), 1680 (CO); $^1$H NMR (DMSO-$d_6$) δ: 2.19 (s, 3H, $COCH_3$), 7.3−7.80 (m, 13 H, $C_6H_5$, 2 $C_6H_4$), 9.80 (s 1H, NH); MS: m/z = 379 [$M^+$]; Anal. Calcd. for $C_{23}H_{17}N_5O$: C, 72.81; H, 4.52; N, 18.46%. Found: C, 72.80; H, 4.55; N, 18.77%.

*6-[1,2-Bis(2-phenylhydazono)propyl]-6H-indolo-[2,3-b]quinoxaline* (**8**). *Method (A).* A mixture of compound **7** (0.38 g, 1 mmol) and phenylhydrazine

(0.11 g, 1 mmol) and acetic acid (1 ml) was heated at 120°C for 10 min. The reaction mixture was triturated with ethanol, the solid product, so formed, was collected by filtration.

*Method (B)*. The same experimental procedure as it is described for the synthesis of compound **7** was adopted using **10** instead of compound **6**.

Yield 78%; dark red crystals from ethanol; m.p. 320°C; IRS (KBr) ν ($cm^{-1}$): 3430 (NH), 2980, 2850 ($CH_3$); $^1H$ NMR (DMSO-$d_6$) δ: 2.65 (s, 3H, $CH_3$), 7.2−8.25 (m, 18H, $2C_6H_5$, $2C_6H_4$), 8.12, 8.15 (2br s, 2H, 2NH); MS: m/z = 469 [$M^+$]; Anal. Calcd. for $C_{29}H_{23}N_7$: C, 74.18; H, 4.94; N, 20.88%. Found: C, 74.30; H, 4.92; N, 21.22%.

*3-Amino-5-hydroxy-6-(6H-indolo[2,3-b]quinoxalin-6-yl)biphenyl-2-carbonitrile* (**9**). Benzylidene malononitrile (1.5 g, 10 mmol) was added to a solution of **6** (2.8 g, 10 mmol) in dioxane (30 ml) in the presence of few drops of piperidine. The reaction mixture was heated under reflux for 6 h. The amount of solvent was reduced under vacuum, the mixture was diluted with water and acidified with dilute hydrochloric acid. The solid product obtained was collected by filtration.

Yield 70%; brown solid from ethanol; m.p. 325°C; IRS (KBr) ν ($cm^{-1}$): 3400 (OH), 3420, 3330 ($NH_2$), 2210 (CN); $^1H$ NMR (DMSO-$d_6$) δ: 8.72 (br s, 2H, $NH_2$), 9.68 (s, 1H, OH), 7.3−8.10 (m, 14H, $2C_6H_4$, $C_6H_5$, $C_6H$); MS: m/z = 427 [$M^+$]; Anal. Calcd. for $C_{27}H_{17}N_5O$: C, 75.86; H, 4.01; N, 16.38%. Found: C, 75.84; H, 4.10; N, 16.59%.

*1-(6H-Indolo[2,3-b]quinoxalin-6-yl)-2-phenylhydrazonopropane* (**10**). The same experimental procedure as it was described for the synthesis of **8** (Method A) was adopted using compound **6** instead of **7**.

Yield 92%; orange crystals from ethyl alcohol; m.p. 315°C; IRS (KBr) ν ($cm^{-1}$): 3240 (NH); $^1H$ NMR (DMSO-$d_6$) δ: 2.62 (s, 3H, $CH_3$), 4.45 (s, 2H, $CH_2$), 7.33−8.10 (m, 13H, $C_6H_5$, $2C_6H_4$), 8.20 (br s, 1H, NH); MS: m/z = 365 [$M^+$]; Anal. Calcd. for $C_{23}H_{19}N_5$: C, 75.59; H, 5.24; N, 19.16%. Found: C, 75.56; H, 5.25; N, 19.68%.

*5-Cyano-3-(6H-indolo[2,3-b]quinoxalin-6-yl)-4-methyl-6-oxo-1-phenylpyridazine* (**13**). Malononitrile (0.66 g, 10 mmol) was added to compound **7** (3.79 g, 10 mmol) in the presence of acetic acid (1 ml) and anhydrous ammonium acetate (1 g). The reaction mixture was heated at 120°C for 15 min, then triturated with ethanol. The solid product, so formed, was collected by filtration.

Yield 85%; dark yellow solid from ethanol; m.p. 345°C; IRS (KBr) ν ($cm^{-1}$): 2230 (CN), 1680 (CO); $^1H$ NMR (DMSO-$d_6$) δ: 2.5 (s, 3H, $CH_3$), 7.5−8.4 (m, 13 H, $C_6H_5$, $2C_6H_4$); MS: m/z = 428 [$M^+$]; Anal. Calcd. for $C_{26}H_{16}N_6O$: C, 72.89; H, 3.76; N, 19.61%. Found: C, 72.92; H, 3.80; N, 19.95%.

*4-Amino-7-(6H-indolo[2,3-b]quinoxalin-6-yl)-3-oxo-2-phenylthieno[3,4-d]pyridazine* (**14**). Elemental sulphur (0.32 g, 10 mmol) was added to a solution of compound 13 (4.28 g, 10 mmol) in DMF (30 ml) in the presence of piperidine (0.5 ml). The reaction mixture was heated for 6 h. The solvent was reduced to half of its volume, poured onto water and neutralized with HCl, the solid product, so formed, was collected by filtration.

Yield 73%; yellow crystals from ethanol; m.p. > 360°C; IRS (KBr) ν ($cm^{-1}$): 3420, 3310 ($NH_2$), 1685 (CO); $^1H$ NMR (DMSO-$d_6$) δ: 5.75 (s, 1H, thienyl 5-H), 7.03−8.20 (m, 15 H, $2C_6H_4$, $C_6H_5$, $NH_2$); MS: m/z = 460 [$M^+$]; Anal. Calcd. for $C_{26}H_{16}N_6SO$: C, 67.81; H, 3.50; N, 18.25; S, 6.96%. Found: C, 67.67; H, 3.55; N, 18.58; S, 7.15%.

*3-(6H-Indolo[2,3-b]quinoxalin-6-yl)-4-oxo-1-phenylpyridazine* (**16**). A mixture of compound **7** (4.5 g, 12 mmol) and DMFDMA (1.19 g, 10 mmol) in toluene (30 ml) was heated for 18 h. The solvent was evaporated under vacuum and the solid product, so formed, was collected by filtration.

Yield 80%; pale yellow crystals from ethanol; m.p. 340°C; IRS (KBr) ν ($cm^{-1}$): 1700 (CO); $^1H$ NMR (DMSO-$d_6$) δ: 7.10−8.30 (m, 13H, $2C_6H_4$, $C_6H_5$), 6.98, 9.09 (2d, 2H, pyridazine 5-H, 6-H); MS: m/z = 389 [$M^+$]; Anal. Calcd. for $C_{24}H_{15}N_5O$: C, 74.02; H, 3.88; N, 17.98%. Found: C, 74.13; H, 3.86; N, 18.30%.

*4-(N,N-Dimethylamino)-3-(6H-indolo[2,3-b]quinoxalin-6-yl)-2-butanone* (**19**). A mixture of **6** (2.8 g, 10 mmol) and DMFDMA (1.4 g, 12 mmol) in xylene (30 ml) was refluxed for 14 h. The reaction mixture was evaporated in vacuum to afford the enaminone **19**.

Yield 92%; yellow crystals from dioxane; m.p. 300°C; IRS (KBr) ν ($cm^{-1}$): 1690 (CO), 1600 (C=C, olefinic); $^1H$ NMR (DMSO – $d_6$) δ: 6.0 (s, 1H, CH), 2.30 (s, 6H, $NMe_2$), 2.15 (s, 3H, $CH_3$), 7.31−8.0 (m, 8H, $2C_6H_4$); MS: m/z = 330 [$M^+$]; Anal. Calcd. for $C_{20}H_{18}N_4O$: C, 72.71; H, 5.49; N, 16.96%. Found: C, 72.75; H, 5.52; N, 17.41%.

*3-Cyano-5-(6H-indolo[2,3-b]quinoxalin-6-yl)-6-methyl-2-oxo-1H-pyridine* (**23**). A mixture of compound 19 (3.3 g, 10 mmol) and malononitrile (0.66 g, 10 mmol) in absolute ethanol (50 ml) and a few drops of piperidine was stirred for 1 h. The solvent was evaporated under reduced pressure. The solid product, so formed, was collected by filtration.

Yield 90%; dark yellow solid from dimethyl formamide/ethanol; m.p. 317°C; IRS (KBr) ν ($cm^{-1}$): 3400 (NH), 2220 (CN), 1660 (CO); $^1H$ NMR (DMSO-$d_6$) δ: 1.99 (s, 3H, $CH_3$), 8.43 (s, 1H,

pyridinyl 4-H), 7.3−8.0 (m, 8H, $2C_6H_4$), 13.20 (br, 1H, NH), MS: m/z = 351 [$M^+$]; Anal. Calcd. for $C_{21}H_{13}N_5O$: C, 71.78; H, 3.73; N, 19.93%. Found: C, 71.75; H, 3.74; N, 20.01%.

*7-Amino-3H-5-(6H-indolo[2,3-b]quinoxalin-6-yl)-4-methylpyrazolo[3,4-b]pyridine* (**27**). Hydrazine hydrate (0.5 g, 10 mmol) was added to a solution of **23** (3.5 g, 10 mmol) in ethanol (40 ml). The reaction mixture was heated under reflux for 8 h, then evaporated in vacuum. The remaining product was triturated with diethyl ether then collected by filtration.

Yield 80%; yellow crystals from dioxane; m.p. > 360°C; IRS (KBr) ν ($cm^{-1}$): 1620 (C=N), 3440, 3310 (NH, $NH_2$), 1600 (C=C); $^1$H NMR (DMSO-$d_6$) δ: 7.31−8.35 (m, 10H, $2C_6H_4$, $NH_2$), 2.56 (s, 3H, $CH_3$), 11.23 (br s, 1H, NH), 6.88 (s, 1H, pyridyl 4-H); MS: m/z = 365 [$M^+$]; Anal. Calcd. for $C_{21}H_{15}N_7$: C, 69.04; H, 4.14; N,26.83%. Found: C, 69.06; H, 4.17; N, 27.13%.

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# НОВИ ПРОЦЕДУРИ ЗА СИНТЕЗ НА ТРИАЗИНО[5,6-b]ИНДОЛ И ИНДОЛО[2,3-b]ХИНОКСАЛИНОВИ ПРОИЗВОДНИ


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(Резюме)

При реакцията на изатин с *о*-фенилендиамин е получен 6*H*-индоло[2,3-b]хиноксалин. При реакцията на изатин със семикарбазид хидрохлорид е получен 2-(2-оксоиндолин-3-илиден)хидразин карбоксамид, който циклизира до 2*H*-[1,2,4]триазино[5,6-b]индол-3(5*H*)-он. От последното съединение са синтезирани 1,2,4-триазино[5,6-b]индоло производни. 6*H*-Индоло[2,3-b]хиноксалин при реакция с хлороацетон дава 1-(6*H*-индоло[2,3-b]хиноксалин-6-ил)пропан-2-он, който лесно се сдвоява с бензендиазониев хлорид до арилхидразоново производно, от което се получават индоло[2,3-b]хиноксалинилтиено[3,4-d]пиридазин и индоло[2,3-b]хиноксалинилпиридазинови производни. Производни на индоло[2,3-b]хиноксалинилпиридин са синтезирани от 4-(N,N-диметиламино)-3-(6*H*-индоло[2,3-b]хиноксалин-6-ил)-2-бутанон. Представени са химични и спектрални доказателства за новите съединения.