Action of Hydrazines on 2-(2-Oxindolin-3-ylidene)malononitrile, (*E*,*Z*)-Ethyl 2-cyano-2-(2-oxindolin-3-ylidene)acetate and Isatin-β-thiosemicarbazone as a Source of Spiro Indoline-pyrazole Systems

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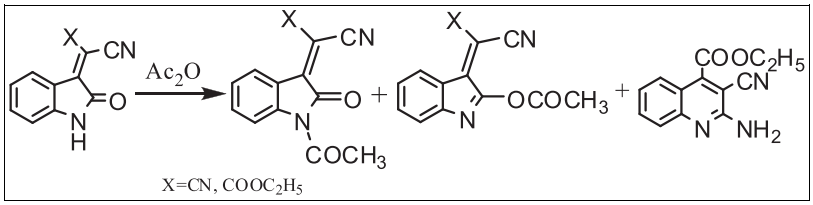

2-(2-Oxindolin-3-ylidene)malononitrile (**1a**) or (*E*,*Z*)-ethyl 2-cyano-2-(2-oxindolin-3-ylidene)acetate (**1b**) or isatin-β-thiosemicarbazone (**1c**) undergoes reactions with prototype hydrazine hydrate itself and some of its simple congeners to give hydrazone derivatives bearing indoline-2-one moiety **(2)**. The hydrazone derivatives **(2)** when heated with acetyl acetone or ethyl acetoacetate in dry pyridine afforded the spiro indoline derivatives **(3a**, **b)**. Also, cinnoline derivative **(9)** is obtained by action of hydrazine hydrate on the *N*-acetyl derivative of (**6a)**. The structures of the newly synthesized compounds were evaluated by IR, ^{1}H-NMR spectroscopy, mass spectra and elemental analyses.

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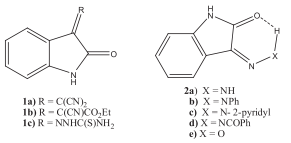
INTRODUCTION

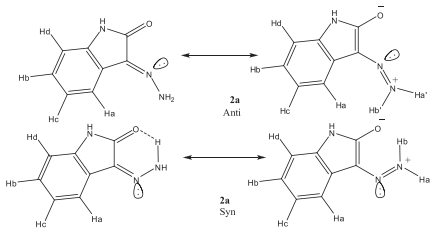
The interest in isatin derivatives stems from their pharmacological [1,2] and industrial application [3,4]. Substituted isatins are found in plants: melosatin alkaloids can be obtained from the caribbean tumorigenic plant *Melochia tomentosa* [5–7] as well as in fungi; 6-(3′-methylbuten-2′-yl)isatin was isolated from *Streptomyces albus* [8,9]. N-substituted isatins [10] are reported to show a wide range of biological activities such as antibacterial [11], anti-fungal [12,13], antiviral [14], anti-HIV [15,16] and anti-leukemia [17]. These compounds were also reported to have effects on central nervous system [18,19]. Isatin and a number of its derivatives posses a reactive carbonyl group that readily undergoes condensation reactions under mild conditions [20]. It was therefore suitable as a precursor for the synthesis of heterocycles incorporating spiro indolines [21,22] for pharmacological evaluation [23], medicinal application as muscle relaxants, and anti-inflammatory agents [24,25].

In view of these observations, we have now investigated the reaction of 2-(2-oxindolin-3-ylidene)malononitrile (**1a**) or (*E*, *Z*)-ethyl 2-cyano-2-(2-oxindolin-3-ylidene)acetate (**1b**) or isatin-β-thiosemicarbazone (**1c**) with hydrazine derivatives to explore the possibility of the formation of novel spiro system incorporating indole and pyrazole moieties.

Treatments of 2-(2-oxindolin-3-ylidene)malononitrile (**1a**), (*E*,*Z*)-ethyl 2-cyano-2-(2-oxindolin-3-ylidene)acetate (**1b**), or isatin-β-thiosemicarbazone (**1c**) in ethanol under heating with the prototype hydrazine hydrate itself afforded the hydrazone derivative **2a** in one-pot reaction. In addition, the reactions of **1a**, **b** with the congeners of hydrazine hydrate such as phenylhydrazine, 2-pyridylhydrazine, and benzoyl hydrazine in ethanol afforded the hydrazide derivatives **2b–d** in good yields. Moreover, the reaction of **1b** with hydroxyl amine hydrochloride yielded the oxime derivative **2e** as shown.

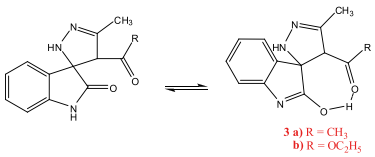


The structures of compounds **2a–e** were substantiated from their microanalytical and spectral data. Thus, their IR spectra show bands corresponding to NH and CO, as well as a band for OH in case of **2e**. Further support for the assigned structures of compounds **2a–e** was gained from ^{1}H-NMR spectra, which exhibit signals characteristic for aromatic protons in addition to NH and OH protons in the downfield region exchangeable with D_2O. The configurational assignment of compounds **2a–e** as the Z-configurated isomers was based on the higher δ values for the signals of NH or OH protons and the lower frequency of absorption for carbonyl group, which suggests their existence as their chelated forms shown. Inspection of ^{1}H-NMR spectrum of compound **2a** shows its existence as a mixture of *syn* and *anti* in a ratio of 74 : 26 (see Experimental section). Moreover, the mass spectral data are in accord with their proposed structures as they show the molecular ion peaks as well as some of important peaks.

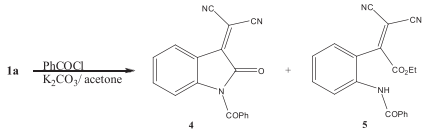


The formation of compounds **2a–e** can be rationalized on the basis of expulsion of the dicyanomethylene, cyanoc arboethoxymethylene, or thiosemicarbazonyl groups with the formation of imine derivatives as depicted in Schemes 1 and 2. H_2S Gas was evolved during the reaction progress of **1c** with hydrazine hydrate, which was detected by blackening of a paper wet with lead acetate solution.

The hydrazone derivative **2a** when heated with acetyl acetone or ethyl acetoacetate in dry pyridine afforded the spiro derivatives **3a**, **b**. The IR spectra of compounds **3a**, **b** show absorption bands correlated with NH, C═O and C═N groups. Their ^{1}H-NMR spectra exhibit signals corresponding to NH, OH, CH_3, and aromatic protons, as well as signals for CH_3CH_2 protons in case of **3b**. The appearance of a signal in the downfield region at δ 14 corresponding to OH proton suggests the existence of compounds **3a**, **b** in solution as their chelated lactim forms shown.



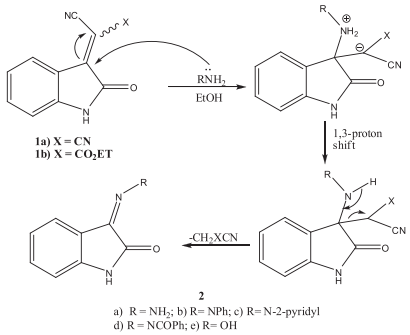
The authors aimed to undergo benzoylation or acylation to compounds **1a**, **b** hoping to prevent the removal of dicyanomethylene or cyanocarboethoxymethylene moiety by the action of hydrazine derivatives. Thus, refluxing of **1a** with benzoyl chloride in dry acetone in the presence of anhydrous potassium carbonate as a base yielded an adduct that was proved to be a mixture of two compounds, the 2-(1-benzoyl-2-oxindolin-3-ylidene) malononitrile (**4**) and ethyl 2-(2-benzamidophenyl)-3,3-dicyanoacrylate **5** (cf. Equation 1). Compound **5** is formed during crystallization with ethanol.



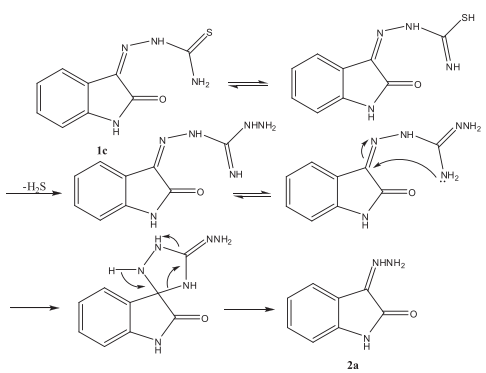
The structures of compounds **4** and **5** are evidenced from their IR spectrum that displayed bands corresponding to NH, CN, CO (ester), and CO (amide). Their ^{1}H-NMR spectrum is in accord with the proposed structures as it showed signals for NH, ethyl, and aromatic protons. Another support for the existence of this adduct as a mixture of the two compounds **4** and **5** is gained from mass spectrum. This is evidenced from GCMS diagram, which exhibits two bands, one corresponding to the compound **4** and the other to compound **5**. The mass spectrum of **4** does not show the molecular ion peak, instead it shows $[M^+ - (CO + HCN)]$ peak. However, the MS for compound **5** shows the correct molecular ion peak beside some of important peaks. On doing crystallization of the previous adduct using benzene instead of ethanol, we get the compound **4** as the sole product. This is a good proof for the incorporation of ethanol in the formation of compound **5**.

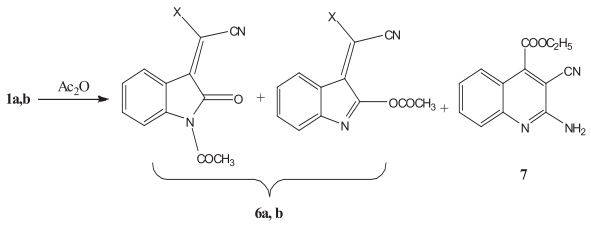
Heating of compounds **1a**, **b** in acetic anhydride furnished a mixture of *N*-acetyl and *O*-acetyl derivatives **6a**, **b** as well as the quinoline derivative **7** in case of **1a** (cf. Equation 2). All Attempts to separate the isomeric components **6a**, **b** by fractional crystallization or column chromatography failed because of the low percentage of *O*-acetyl derivative and the small difference in the RF for the two isomers. On the other hand, compound **7** was obtained on heating of **1a** with glacial acetic acid then crystallization of the adduct with ethanol. The existence of compounds **6a**, **b** as mixtures of *N*-acetyl and *O*-acetyl isomers in the ratios of 71 : 29 and 62 : 38% were evidenced from their ^{1}H-NMR spectra that show also two singlet signals corresponding to *N*-methyl and *O*-methyl protons at δ 2.61, 2.58, and 2.63, 2.56 ppm for **6a**, **b**, respectively.

Scheme 1



Scheme 2





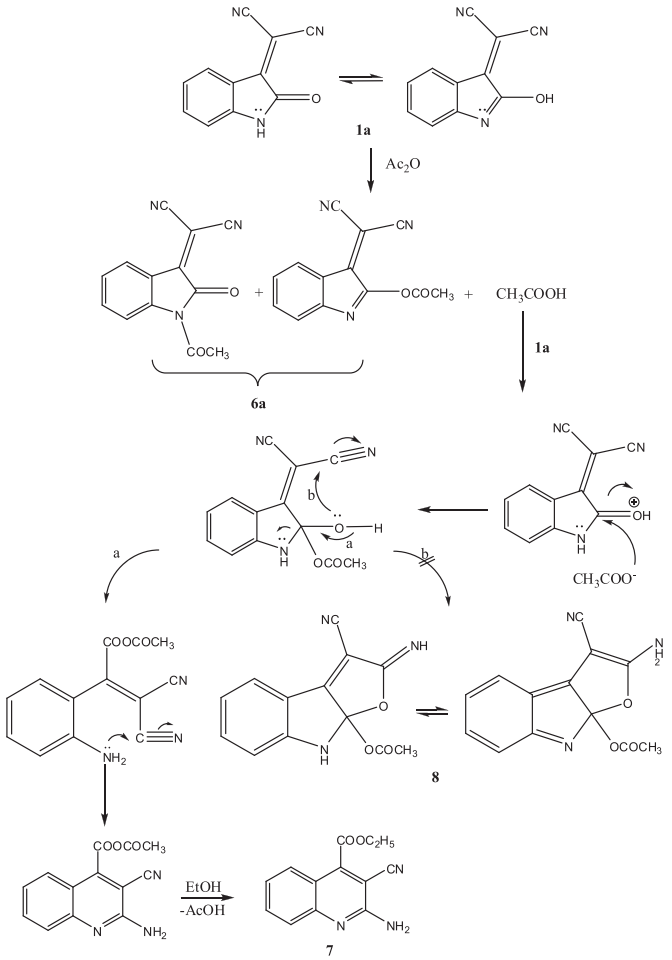
The structures of **6a**, **b** were deduced from their microanalytical and spectral data. Thus, their IR spectra show bands correlated with CN and CO groups. Further evidence was gained from their ^{1}H-NMR spectra that displayed signals corresponding to aliphatic and aromatic protons. The appearance of two singlet signals in ^{1}H-NMR spectra of **6a**, **b** corresponding to two methyl protons is in accord with their existence as a mixture of *N*-acetyl and *O*-acetyl derivatives. The mass spectrum of **6a** exhibits the correct molecular ion peak in addition to other important peaks.

The structure of quinoline derivative **7** was ascertained from its spectral data, which were in accord with the suggested structure. The formation of compounds **6a** and **7** can be rationalized as shown in Scheme 3.

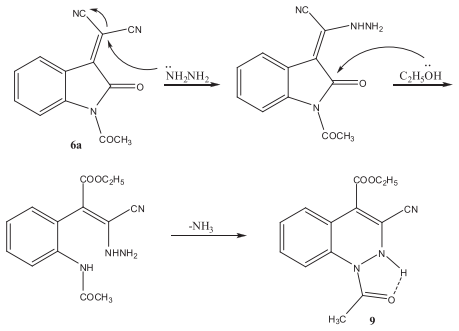
Treating an ethanolic solution of **6a** with hydrazine hydrate yielded the cinnoline derivative **9** as well as the hydrazone derivative **2a** in minor amounts. However, similar treatment of **6b** with hydrazine hydrate gave the *N*-acetyl hydrazone **10** and small amounts of the hydrazone derivative **2a**. The structure of **9** is deduced from microanalytical and spectral data. Its IR spectrum shows bands characteristic for NH, CN, CO (ester), and CO (amide). The ^{1}H-NMR spectrum is in accord with the suggested structure.The higher δ value for the signal of NH proton suggests the existence of **9** as its chelated form shown. Its MS shows the molecular ion peak, beside some of important peaks, which is in accord with the proposed structure. Compound **9** is formed from the *N*-acetyl isomer as depicted in Scheme 4. However, compound **2a** is formed from the *O*-acetyl isomer through the attack of hydrazine at the carbonyl function of *O*-acetyl group with concomitant removal of the dicyanomethylene group by the attack with another molecule of hydrazine hydrate (cf. Scheme 1).

The structure of compound **10** is substantiated from its microanalytical and spectral data. Its IR spectrum shows bands attributable to NH_2, NH, and CO groups. The ^{1}H-

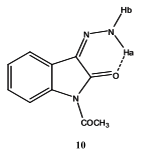
Scheme 3



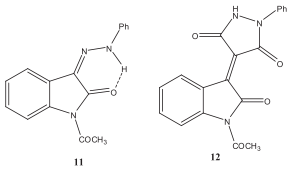
Scheme 4



NMR spectrum displays two broad doublet signals for 2 NH protons, singlet signal for CH_3 protons and multiplet signals for aromatic protons. The appearance of two signals for protons of NH_2 group as two broad doublets instead of one broad singlet signal equivalent to two protons is a good evidence for the magnetic non-equivalence of the two protons, which was produced because of chelation. This suggests the existence of **10** in the syn conformation. Recalling **10** is formed from the *N*-acetyl isomer; however, **2a** is formed from *O*-acetyl isomer (cf. Scheme 1).



Similar treatment of **6a**, **b** with phenylhydrazine yielded an adduct that could have one of the two possible structures **11** or **12** beside compound **2b** in minor amounts. The IR and ^{1}H-NMR spectra of this adduct are in agreement with the two suggested structures and cannot differentiate between them. The appearance of a peak at m/z 279 that corresponds to the molecular ion of compound **11** is a good evidence for the existence of this adduct as structure **11** and not **12**. It is worth to mention that compound **11** is formed from the *N*-acetyl isomer through extrusion of dicyan omethylene or cyanocarboethoxymethylene moiety. However, **2b** is formed from the *O*-acetyl isomer by the same route in addition to the removal of acetyl group by the attack with another molecule of phenylhydrazine.



CONCLUSION

The action of nitrogen nucleophiles on 2-(2-oxindolin-3-ylidene)malononitrile, (*E*,*Z*)-ethyl 2-cyano-2-(2-oxindolin-3-ylidene)acetate proceeds through attack at β carbon of 2-oxindoline moiety with extrusion of the dicyanomethylene group or cyanocarboethoxymethylene group.

EXPERIMENTAL

Melting points were measured on an electrothermal melting point apparatus and were uncorrected. The elemental analyses were done on a Perkin-Elemer 2400 CHN elemental analyzer. The IR spectra were recorded on FTIR Maltson (infinity series) spectrophotometer as KBr discs. The ^{1}H-NMR spectra were measured on Varian Gemini 300 MHz spectrometer, with chemical shift (δ) expressed in ppm downfield from TMS as internal standard, in DMSO-d_6. Mass spectra were determined on Shimadzu GC-MSQP 1000 EX instrument operating at 70 eV. TLC was run using TLC aluminum sheets silica gel F_{254} (Merck). It was carried out the monitoring of the progress of all reactions and homogeneity of the synthesized compounds.

2-(2-Oxindolin-3-ylidene)malononitrile (**1a**) or (*E*,*Z*)-ethyl 2-cyano-2-(2-oxindolin-3-ylidene)acetate (**1b**) or isatin-β-thiosemicarbazone (**1c**) were synthesized as mentioned in the literatures [26,27].

Reactions of 1a–c with hydrazine hydrate and its derivatives. A mixture of **1a–c** 1.5 g (0.007 mol) and hydrazine hydrate 1.5 ml, phenylhydrazine 0.76 g, 2-pyridyl hydrazine 0.76 g, or benzoyl hydrazine 0.95 g in 30 ml ethanol was refluxed for 7 h. The reaction mixture was concentrated and left to cool. The precipitated solid was filtered and recrystallized from suitable solvent to give.

(Z,E)-3-Hydrazonoindolin-2-one (2a). This compound was obtained as yellow crystals (ethanol), (78–98%), mp 228–230°C; IR: 3356, 3152 NH, 3050 aryl-H, 1686 CO 1659 C═N, 1589, 1551 C═C, 748 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 6.86 (d, 1H, H_d, J_o = 6.9 Hz), 6.98 (t, 1H, H_c, J_o = 6.9, 7.8 Hz), 7.15 (t, 1H, H_b, J_o = 6.9, 7.8 Hz), 7.36 (d, 1H, H_a, J_o = 7.5 Hz), 10.09 (br.s, 1H, NHCO, exchangeable); For anti isomer (E-isomer): 8.78 (d, 1H, $NH_{b'}$, exchangeable), 10.37 (d, 1H, NHa′, exchangeable); For syn isomer (Z-isomer): 9.58 (d, 1H, NH_b, exchangeable), 10.52 (d, 1H, NH_a, exchangeable); ms: *m/z* 161 ($M^{+\cdot}$), 160 ($M^+ - 1$), 144 ($M^+ - OH$), 133 ($M^+ - CO$), 104, 91, 75, 62. Anal. Calcd. for $C_8H_7N_3O$: C, 59.62; H, 4.38; N, 26.07. Found: C, 59. 23; H, 4.12; N, 25.87.

(Z)-3-(2-Phenylhydrazono)indolin-2-one (2b). This compound was obtained as yellow crystals (ethanol), (64%), mp 208–210°C; IR: 3165, 3121 NH, 3056, 3024 aryl-H, 1684 C═O, 1617 C═N, 1595, 1555 C═C, 746, 688 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 6.89–7.51 (m, 9H, Ar-H), 11.20 (br.s, 1H, NHCO, exchangeable), 12.70 (br.s, 1H, NH-N, exchangeable); Anal. Calcd. for $C_{14}H_{11}N_3O$: C, 70.87; H, 4.67; N, 17.71. Found: C, 70.73; H, 4.34; N, 17.82.

(Z)-3-(2-(Pyridin-2-yl)hydrazono)indolin-2-one (2c). This compound was obtained as yellow crystals (ethanol/dioxan), (56%), mp 282–284°C; IR: 3186, 3138 NH, 3063, 3019 aryl-H, 1693 CO 1620 C═N, 1600, 1569 C═C, 732 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 6.91–8.24 (m, 8H, Ar-H), 11.10, 12.76 (two br.s, 2H, 2NH, exchangeable); ms: *m/z* 238 ($M^{+\cdot}$), 210 ($M^+ - CO$), 209 ($M^+ - (CO + H)$), 208, 104, 79. Anal. Calcd. for $C_{13}H_{10}N_4O$: C, 65.54; H, 4.23; N, 23.52. Found: C, 65. 66; H, 4.11; N, 23.33.

(Z)-N′-(2-Oxindolin-3-ylidene)benzohydrazide (2d). This compound was obtained as orange crystals (ethanol), (93 %), mp

278–280°C; IR: 3235, 3167 NH, 3063 aryl-H, 1689 CO 1621C═N, 1600, 1538 C═C, 753, 689 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 6.94 (d, 1H, *J* = 5.0 Hz), 7.09 (t, 1H, *J* = 4.6 Hz), 7.37 (t, 1H, *J* = 4.6 Hz), 7.59 (t, 3H, *J* = 4.0 Hz), 7.66 (d, 1H, *J* = 4.1 Hz 7.87 (d, 2H, *J* = 4.6 Hz), 12.37 (br.s, 1H, NH indolo exchangeable), 13.92 (br.s, 1H, NHCO, exchangeable); ms: *m/z* 265 (M^+), 237 ($M^+ - CO$), 179, 160 ($M^+ - PhCO$), 119, 117, 105 (PhCO), 77 (Ph). Anal. Calcd. for $C_{15}H_{11}N_3O_2$: C, 67.92; H, 4.18; N, 15.84. Found: C, 67.78; H, 4.02; N, 15.66.

Reaction of 1b with hydroxylamine hydrochloride. A solution of **1b** 0.5 g (0.0021 mol) in ethanol (15 mL), hydroxylamine hydrochloride 0.14 g (0.0023 mol), and ammonium acetate 0.14 g (0.0018 mol) was refluxed for 4 h. The precipitated solid was filtered off and recrystallized to afford.

(Z)-3-(Hydroxyimino)indolin-2-one (2e). This compound was obtained as orange crystals (ethanol), (80%), mp 206–208°C; IR: 3400–2600 br. OH, 3181 NH, 3089 aryl-H, 1713 CO, 1662 C═N, 1618 C═C, 751 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 6.83 (d, 1H, *J* = 4.6 Hz), 6.97 (t, 1H, *J* = 4.6 Hz), 7.30 (t, 1H, *J* = 4.6 Hz), 7.89 (d, 1H, *J* = 4.6 Hz), 10.67 (br.s, 1H, NH, exchangeable), 13.26 (br.s, 1H, OH, exchangeable); ms: *m/z* 162 (M^+), 145 ($M^+ - OH$), 134 ($M^+ - CO$), 117, 116, 102. Anal. Calcd. for $C_8H_6N_2O_2$: C, 59.26; H, 3.73; N, 17.28. Found: C, 58.98; H, 3.68; N, 17.56.

Reactions of 2a with acetyl acetone and ethyl acetoacetate. A solution of **2a** 0.5 g (0.0031 mol) and acetyl acetone 0.32 g or ethyl acetoacetate 0.57 g in pyridine (15 mL) was refluxed for 7 h, then poured onto cold dilute HCl. The precipitated solid was filtered and recrystallized from a suitable solvent to give.

4′-Acetyl-5′-methyl-2′,4′-dihydrospiro[indoline-3,3′-pyrazol]-2-one (3a). This compound was obtained as red crystals (ethanol), (54%), mp 206–208°C; IR: 3118 NH, 3065 aryl-H, 2987 alkyl-H, 1701 CO 1616 C═N, 1550 C═C, 739 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 2.10 (s, 3H, CH_3CO), 2.24 (s, 3H, CH_3-pyrazole), 5.54 (s, 1H, CH-pyrazole), 6.89 (d, 1H, J_o = 7.8 Hz), 7.02 (t, 1H, J_o = 7.8 Hz, J_m = 1.2 Hz), 7.29 (d, 1H, J_o = 7.5 Hz, J_m = 1.2 Hz), 7.47 (d, 1H, J_o = 7.5 Hz), 10.97 (br.s, 1H, NH, exchangeable),14.80 (br.s, 1H, OH, exchangeable); ms: *m/z* 244 ($M^+ + 1$), 243 (M^+), 228, 215 ($M^+ - CO$), 200 ($M^+ - CH_3CO$), 199, 184, 174, 149, 147, 146, 132, 131, 118, 117, 104, 102, 98, 97, 96, 77, 76. Anal. Calcd. for $C_{13}H_{13}N_3O_2$: C, 64.19; H, 5.39; N, 17.27. Found: C, 63. 93; H, 5.16; N, 17.06.

Ethyl 5′-methyl-2-oxo-2′,4′-dihydrospiro[indoline-3,3′-pyrazole]-4′-carboxylate (3b). This compound was obtained as yellow crystals (light petroleum 60–80/benzene), (85%), mp 156–158°C; IR: 3238 NH, 3102 aryl-H, 2959, 2933, 2896, 2869 alkyl-H, 1703, 1654 CO, 1616 C═N, 1566 C═C, 740 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 0.90 (t, 3H, $\underline{CH_3}CH_2O$–), 2.24 (s, 3H, CH_3 pyrazolo), 4.13 (q, 2H, $CH_3\underline{CH_2}O$–), 5.06 (s, 1H, CH pyrazolo), 6.90 (d, 1H, J_o = 7.8 Hz), 7.03 (t, 1H, J_o = 7.5 Hz), 7.29 (d, 1H, J_o = 7.8 Hz, J_m = 1.2 Hz), 7.46 (d, 1H, J_o = 7.5 Hz), 10.98 (br.s, 1H, NH, exchangeable), 14.17 (br.s, 1H, OH, exchangeable); ms: *m/z* 273 (M^+), 228, 227 ($M^+ - C_2H_5OH$), 200 ($M^+ - CO_2C_2H_5$), 184, 159, 149, 141, 132, 118, 115, 102, 98, 76, 75. Anal. Calcd. for $C_{14}H_{15}N_3O_3$: C, 61.53; H, 5.53; N, 15.38. Found: C, 61.58; H, 5.41; N, 15.12.

Reaction of 1a with benzoyl chloride. A mixture of **1a** 0.5 g (0.0026 mol) and benzoyl chloride 0.3 mL in 20 mL dry acetone and dry potassium carbonate 0.5 g was refluxed for 6 h. The reaction mixture was poured onto ice cold water. The precipitated solid was filtered off and recrystallized to give.

2-(1-Benzoyl-2-oxindolin-3-ylidene)malononitrile (4) *and ethyl 2-(2-benzamidophenyl)-3,3-dicyanoacrylate (**5**).* This compound was obtained as white crystals (ethanol), (29%), mp 168–170°C; IR: 3234 NH, 3059 aryl-H, 2981, 2931, 2874 alkyl-H, 2231 CN, 1728 CO ester, 1660 CO amide, 1576 C═C, 695, 770 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 1.45 (t, 3H, CH_3CH_2O–, *J* = 7.2, 7.5 Hz), 4.58 (q, 2H, $CH_3\underline{CH_2}O$–, *J* = 7.2 Hz), 7.57–8.14 (m, 9H, Ar-H), 11.87 (br.s, 1H, NH, exchangeable); ms: *m/z* for compound **4**: 245 ($M^+ - (CO + HCN)$), 169, 142, 141, 122, 114, 105 (PhCO), 77 (Ph); for compound **5**: 345 (M^+), 344 ($M^+ - H$), 317 ($M^+ - CO$), 316, 140, 105 (PhCO), 77 (Ph).

Reactions of 1a, b with acetic anhydride. A solution of **1a** or **b** 1 g in 10 mL acetic anhydride was refluxed for 7 h. Concentrate the reaction mixture, filter the solid precipitated and then fractionally crystallize the compounds **6a** and **7** produced in case of **1a**.

2-(1-Acetyl-2-oxindolin-3-ylidene)malononitrile and 3-(dicyanomethylene)-3H-indol-2-yl acetate (6a). This compound was obtained as red crystals (pet. ether 60–80), (20%), mp 162–164°C; IR: 3077, 3019 aryl-H, 2934, 2827 alkyl-H, 2223 CN, 1760, 1712 CO, 1587 C═C, 760 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 2.49 (s, 3H, $OCOCH_3$), 2.58 (s, 3H, $NCOCH_3$), 7.37–8.27 (m, 4H, Ar-H); ms: *m/z* 237 (M^+), 196, 195 ($M^+ - CH_2{=}C{=}O$), 168, 167. Anal. Calcd. For $C_{13}H_7N_3O_2$: C, 65.82; H, 2.97; N, 17.71. Found: C, 65.63; H, 3.13; N, 17.52.

Ethyl 2-amino-3-cyanoquinoline-4-carboxylate (7). This compound was obtained as yellow crystals (ethanol), (10 %), mp 175–178°C; IR: 3409, 3322, 3149 NH_2, 3087 aryl-H, 2980, 2932 alkyl-H, 2223 CN, 1726 CO ester, 1658 C═N, 1613 C═C, 762 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 1.40 (t, 3H, CH_3CH_2O–, *J* = 6.9, 7.2 Hz), 4.58 (q, 2H, $CH_3\underline{CH_2}O$–, *J* = 6.9, 7.5 Hz), 7.31–8.04 (m, 4H, Ar-H), 7.19 (br.s, 2H, NH_2, exchangeable); ms: *m/z* 242 ($M^{+\cdot} + 1$), 241 (M^+), 213 ($M^+ - CO$), 196, 184, 169, 168, 142, 141, 114, 76, 75. Anal. Calcd. For $C_{13}H_{11}N_3O_2$: C, 64.72; H, 4.60; N, 17.42. Found: C, 64.33; H, 4.93; N, 17.22.

Ethyl 2-cyano-2-(1acetyl-2-oxindolin-3-ylidene)acetate and ethyl 2-cyano-2-(2-acetoxyindolin-3-ylidene)acetate (6b). This compound was obtained as yellow crystals (ethanol), (90 %), mp 97–100°C; IR: 3124, 3095 aryl-H, 2992, 2940, 2909 alkyl-H, 2213 CN, 1756, 1731 C═O, 1623 C═N, 1594 C═C, 755 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): For *N*-acetyl isomer δ 1.32 (t, 3H, $COOCH_2\underline{CH_3}$, *J* = 6.9, 7.2 Hz), 2.63 (s, 3H, $COCH_3$), 4.45 (q, 2H, $COOCH_2\underline{CH_3}$, *J* = 6.9, 7.2 Hz), 7.29 (t, 1H, J_o = 7.2, 7.8 Hz, J_m = 1.5 Hz), 7.62 (t, 1H, J_o = 8.1 Hz), 8.08 (dd, 1H, J_o = 7.5 Hz), 8.16 (t, 1H, J_o = 7.5, 7.8 Hz). For *O*-acetyl isomer *δ* 1.36 (t, 3H, $COOCH_2CH_3$, *J* = 6.9, 7.2 Hz), 2.56 (s, 3H, $COCH_3$), 4.47 (q, 2H, $COOCH_2CH_3$, *J* = 6.9, 7.2 Hz), 7.39 (t, 1H, J_o = 7.8 Hz, J_m = 0.9 Hz), 7.66 (m, 1H, J_o = 8.1 Hz), 8.08 (dd, 1H, J_o = 7.5 Hz), 8.16 (t, 1H, J_o = 7.8 Hz). Anal. Calcd. For $C_{15}H_{12}N_2O_4$: C, 63.38; H, 4.25; N, 9.85. Found: C, 63.62; H, 4.04; N, 9.71.

Reaction of 6a, b with hydrazine hydrate. A solution of **6a** or **b** 0.5 g (0.0018–0.0021 mol) in ethanol (20 mL) and hydrazine hydrate (1 mL) was refluxed for 6 h. The precipitated solid was filtered off and recrystallized from a suitable solvent to give.

Ethyl 1-acetyl-3-cyano-1,2-dihydrocinnoline-4-carboxylate (9). This compound was obtained as yellow crystals (ethanol), (52%), mp 154–156°C; IR: 3258 NH, 3092, 3066 aryl-H, 2983, 2931 alkyl-H, 1727 CO ester, 1680 C═O amide, 1619 C═N, 1575 C═C, 771 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 1.41 (t, 3H, CH_3CH_2O–, *J* = 6.9, 7.5 Hz), 2.18 (s, 3H, CH_3CO), 4.62 (q, 2H,

CH_3CH_2O–, $J = 6.9$, 7.2 Hz), 7.77–8.04 (m, 4H, Ar-H), 11.14 (br.s, 1H, NH, exchangeable); ms: *m/z* 271 (M^+), 270 ($M^+ - 1$), 242, 241, 240, 213, 212, 141, 106, 77 (Ph). Anal. Calcd. For $C_{14}H_{13}N_3O_3$: C, 61.99; H, 4.83; N, 15.49. Found C, 61.72; H, 4.29; N, 15.18.

(Z)-1-acetyl -3-hydrazonoindolin-2-one (10). This compound was obtained as buff crystals (pet. ether 60–80/benzene), (35%), mp 148–150°C; IR: 3398, 3249, 3174 NH_2, NH, 2919, 2851 alkyl-H, 1747, 1707 CO, 1594, 1557 C═N and/or C═C, 751 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 2.61 (s, 3H, CH_3), 7.18–8.26 (m, 4H, Ar-H), 10.17 (broad doublet, 1H, NH_b exchangeable), 10.66 (broad doublet, 1H, NH_a exchangeable). Anal. Calcd. For $C_{10}H_9N_3O_2$: C, 59.11; H, 4.46; N, 20.68. Found: C, 59.25; H, 4.22; N, 20.55.

Reactions of 6a, b with phenylhydrazine. A mixture of **6a** or **b** 0.5 g (0.0018–0.0021 mol) and phenylhydrazine (0.22 g) in ethanol (20 mL) was refluxed for 6 h. The reaction mixture was concentrated and left to stand at room temperature. The solid formed was crystallized from a suitable solvent to give.

(Z)-1-acetyl-3-(2-phenylhydrazono)indolin-2-one (11). This compound was obtained as yellow crystals (benzene), (78–81%), mp 118–121°C; IR: 3229 NH, 3017 aryl-H, 2938 alkyl-H, 1707 CO, 1596, 1554 C═N and/or C═C, 689, 754 cm^{-1}; ^{1}H-NMR (dimethylsulphoxide-d_6): δ 2.68 (s, 3H, CH_3CO), 7.12–8.19 (m, 9H, Ar-H, $J = 7.2$, 7.8 Hz), 12.6 (br.s, 1H, NH, excheangeable); ms: *m/z* 280 ($M^+ + 1$), 279 (M^+), 278 ($M^+ - 1$), 238, 237, 236, 209, 208, 180, 160, 117, 77 (Ph), 65. Anal. Calcd. For $C_{16}H_{13}N_3O_2$: C, 68.81; H, 4.69; N, 15.05. found C, 68.97; H, 4.52; N, 14.82.

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