

Conversion of 2(3*H*)-Furanones Bearing Indole Nuclei Into Novel Amide, Pyrrolone, and Imidazole Derivatives

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ABSTRACT: 2(3*H*)-Furanones **1a–d** having exocyclic double bond and *N*-acetylisatin nucleus were converted into the corresponding novel amides, pyrrolones, and imidazoles via nitrogen nucleophiles. All purposed structures were confirmed by NMR, mass spectra GC/MS, and chemical evidence. © 2003 Wiley Periodicals, Inc. *Heteroatom Chem* 14:434–442, 2003; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/hc.10175

INTRODUCTION

Nitrogen heterocycles constitute an important class of natural and nonnatural products many of which exhibit useful biological activity [1–4]. Isatin, and a number of its derivatives, posses a reactive keto-carbonyl group that readily undergoes condensation reactions under mild conditions [5]. It was therefore speculated that isatin would be a suitable electrophilic component for the Baylis–Hillman reaction

[6] and a precursor for the synthesis of other heterocycles [5,7–9]. Substituted isatins are found in plants, melosatin alkaloids can be obtained from the caribbean tumorigenic plant *Melochia tomentosa* [10–12], as well as in fungi, 6-(3'-methylbuten-2'-yl)isatin was isolated from *Streptomyces albus* [13] and 5-(3'-methylbuten-2'-yl)isatin from *Chaetomium globosum* [14]. The interest in isatin derivatives stems from their pharmacological [15–16] and industrial application [17,18].

RESULTS AND DISCUSSION

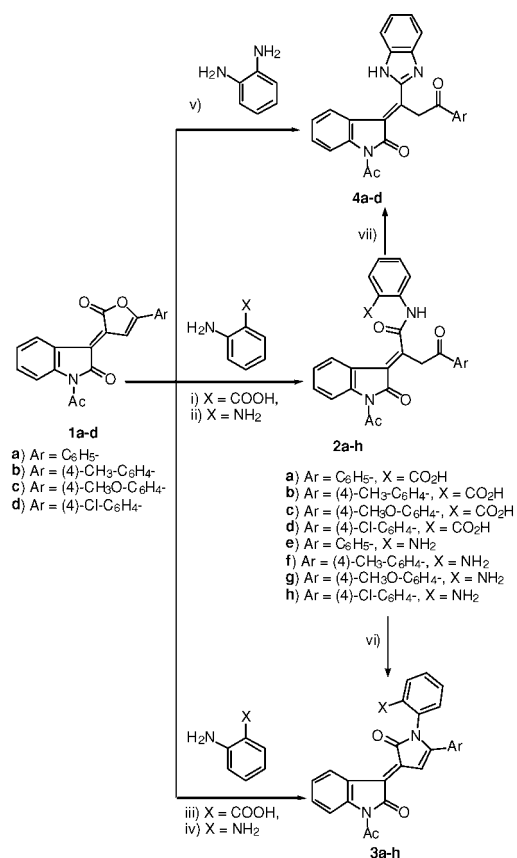
The preparation of (3*E*)-1-acetyl-3(5-aryl-2-oxofuran-3(2*H*)-ylidene)-1,3-dihydro-2*H*-indol-2-ones **1a–d** has already been described [19] as part of our previous investigation on 2-(3*H*)-furanones [20–24]. These form only as *E*-isomers. This is consistent with the result described by Long et al. who studied monosubstituted 3-methyleneoxindoles and detected for most of them only the *E*-isomer [25]. In this paper we examine the reactivity of **1a–d** toward some nitrogen nucleophiles. *N*-Acetylisatin derivatives **1a–d** were treated with anthranilic acid and *o*-phenylenediamine under different conditions (Scheme 1). With anthranilic acid in refluxing acetic acid, ring opening occurs with the formation of the *E*-isomers of amides **2a–d** in 59–78% yield (i). This

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SCHEME 1

reaction was repeated in the presence of a catalytic amount of sodium acetate (3 mol%) with ring opening and closure to give imides **3a–d** in 61–80% yield (iii). These compounds when heated neat in the presence of a catalytic amount of fused sodium acetate (3 mol%) were found (by direct comparison of analytical data) to yield products identical to those obtained by ring closure of amides **2a–d** (vi).

The interaction of **1a–d** with *o*-phenylenediamine was examined with or without solvent. When the reaction took place in refluxing ethanol over 3–5 h, ring opening occurred with the formation of **2e–h** in 75–85% yield (ii). But when the reaction took place by heating of pure form to above melting point in the presence of a catalytic amount of sodium acetate (3 mol%), the imides **3e–h** were formed in 56–63% yield (iv). These were found by direct comparison to be identical with the products formed from the ring closure of **2e–h** during heating of pure form with fused sodium acetate (3 mol%) (vi). This reaction was repeated with refluxing acetic

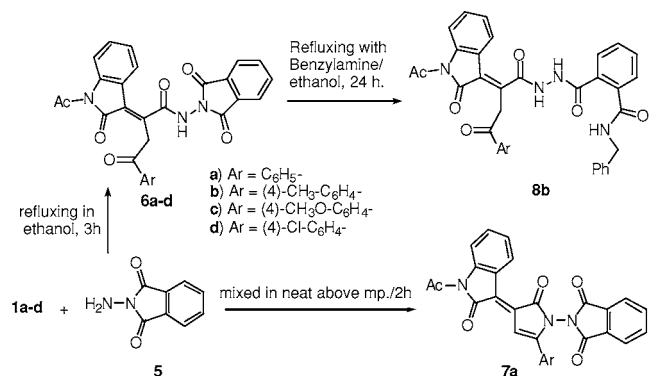
acid in the presence of a catalytic amount of sodium acetate (3 mol%) over 3 h to afford benzoimidazoles **4a–d** in 49–82% yield (v). These were found by direct comparison to be identical with the products that formed from the treatment of **2e–h** with $\text{CH}_3\text{CO}_2\text{H}/\text{CH}_3\text{CO}_2\text{Na}$ (3 mol%) at refluxing temperature (vii). These reactions revealed acid catalysis to be essential for the ring closure of **2e–h**. This reaction condition was consistent with that described by Niume et al. for the formation of *spiro*-benzimidazoles from the reaction of isatin with *o*-phenylenediamine in polar aprotic solvent [26].

In addition, we have examined the reactions of **1a–d** with *N*-aminophthalimide **5** with or without solvent (Scheme 2). When the reaction took place in refluxing ethanol, ring opening occurs to give amides **6a–d** in 40–67% yield. But the reaction is carried out with pure form with heating above melting point over 2–3 h afforded *N*-aminopyrrolones **7a** in 46% yield.

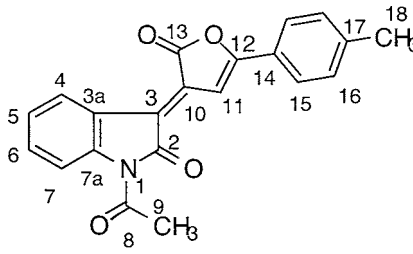
Amide **6b** was treated with equimolar amount of benzylamine in ethanol to give hydrazide **8b** in 62% yield and not *N,N'*-dibenzylphthalimide as we expected [27]. Hydrazide **8b** remains under our investigations and for the conversion of this type of compounds into other heterocyclic compounds with anticipated biological activity.

EXPERIMENTAL

Melting points were determined on a Boetius hot-stage apparatus and are uncorrected. Chromatographic separations were performed using silica gel (Merck, 70–230 mesh). Thin-layer chromatography was carried out on Macherey-Nagel precoated silica plate (0.25 mm layer thickness). ^1H and ^{13}C NMR spectra were recorded with a Gemini 200 spectrometer in CDCl_3 solution unless otherwise specified (internal standard TMS). Mass spectra were



SCHEME 2

TABLE 1 ^{13}C Chemical Shifts δ [C_6H_5] CDCl_3 for **1b**


C-2	163.2	C-10	134.1
C-3	134.7	C-11	106.0
C-3a	133.1	C-12	162.1
C-4	127.3	C-13	168.8
C-5	124.1	C-14	131.1
C-6	129.5	C-15	129.2
C-7	118.1	C-16	128.4
C-7a	142.8	C-17	105.9
C-8	170.3	C-18	28.8
C-9	47.8		

taken on a VG Trio-2 and GC/MS-QPL000EX (EI, 70 eV) apparatus. IR spectra were recorded with a Perkin-Elmer 1430 instrument in KBr disks. Elemental analyses were performed by M-H-W Laboratories (Phoenix, AZ) at Microanalytical Center of Cairo and Ain Shams Universities.

General Procedure for **1a–d**

2-(3H)-Furanones **1a–d** were prepared following the literature method [19,27], via condensation reactions of isatin (0.01 mol) with 3-arylpropionic acid (0.01 mol) in (10 ml) acetic anhydride and fused sodium acetate (0.03 mol) under Perkin conditions, which yielded the corresponding *E*-isomers as the only product, with no detectable amount of the *Z*-isomers being identified by TLC and ^1H NMR. The reddish-green precipitate was collected by filtration and recrystallized from acetic acid to give **1a–d**.

(3*E*)-1-Acetyl-3(2-oxo-5-phenylfuran-3(2H)-ylidene)-1,3-dihydro-2H-indol-2-one (**1a**). Reddish-green crystals 2.65 g, 80% yield, mp 210–211°C (lit. [19,27] 209–211°C); IR, 3445–3155 (bv) for (NH), 1790 (C=O), 1715–1730 (C=O), 1550 (C=N), 1500 (C=C) cm^{-1} ; ^1H NMR (CDCl_3 , 200 MHz): δ 8.89–8.34 [m, 5H, Ph-H], 8.22 (s, 1H, $-\text{CH}=\text{C}$), 7.83 [d, 2H, J = 9.0 Hz, Isatin-H (7)], 7.44 [t, 1H, J = 9.0 Hz, Isatin-H(6)], 7.27 [t, 1H, J = 9.0 Hz, Isatin-H(5)], 7.03 [d, 1H, J = 9.0 Hz, Isatin-H(4)], 2.75 (s, 3H, COCH_3). Calcd. for $\text{C}_{20}\text{H}_{13}\text{NO}_4$ (331.3): C, 72.50; H, 3.95; N, 4.22. Found: C, 72.40; H, 4.20; N, 4.20.

(3*E*)-1-Acetyl-3-[(5-(4-methylphenyl)-2-oxofuran-3(2H)-ylidene)-1,3-dihydro-2H-indol-2-one (**1b**). Reddish-brown crystals 2.83 g, 82% yield, 224–226°C (lit. [19,27] 225–227°C); IR (KBr pellet): 3431–3158, (br) for (NH), 1826 (C=O), 1614–1645 (C=O), 1595 (C=N), 1538 (C=C) cm^{-1} ; LRMS (EI): m/z 345 (M^+ , 25), 303 (50), 119 (100), 85 (50); GC: t_R = 2.81 min; column: DB-5 6 m $\times$ 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/5 min; ^1H NMR (CDCl_3 , 200 MHz): δ 8.97 [d, 2H, J = 7.78 Hz, $\text{CH}_3-\text{C}_6\text{H}_4$ -(2)], 8.23 [d, 2H, J = 8.06 Hz, $\text{CH}_3-\text{C}_6\text{H}_4$ -(3)], 7.93 (s, 1H, $-\text{CH}=\text{C}$), 7.71 [d, 2H, J = 8.14 Hz, Isatin-H (7)], 7.40 [t, 1H, J = 6.66 Hz, Isatin-H(6)], 7.33 [t, 1H, J = 6.28 Hz, Isatin-H(5)], 7.21 [d, 1H, J = 7.8 Hz, Isatin-H(4)], 2.72 (s, 3H, $-\text{COCH}_3$) 2.39 (s, 3H, $-\text{CH}_3$); Calcd. for $\text{C}_{21}\text{H}_{15}\text{NO}_4$ (345.04): C, 73.03; H, 4.37; N, 4.05. Found: C, 73.10; H, 4.30; N, 4.00.

(3*E*)-1-Acetyl-3[5-(4-methoxyphenyl)-2-oxofuran-3(2H)-ylidene]-1,3-dihydro-2H-indol-2-one (**1c**). Reddish-brown crystals 2.71 g, 75% yield, mp 228–230°C; IR (KBr pellet): 3735–3433 for (NH), 1782 (s), for (C=O), 1609–1745 (m), for (C=O), 11595–633 (s), for (C=N), 1536 (C=C) cm^{-1} ; LRMS (EI): m/z 361 (M^+ , 10), 310 (33.5), 263 (0.73), 262 (1.32), 246 (1.5), 203 (2.01), 202 (1.1), 135 (100), 101 (2), 92 (10); 77 (21), 63 (3.7), 61 (4.5); GC: t_R = 6.919 min; column: DB-5 6 m $\times$ 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min; ^1H NMR (CDCl_3 , 200 MHz): δ 9.07 [d, 2H, J = 7.8 Hz, $\text{CH}_3\text{O}-\text{C}_6\text{H}_4$ -(2)], 8.34 [d, 2H, J = 7.8 Hz, $\text{CH}_3\text{O}-\text{C}_6\text{H}_4$ -(3)], 8.00 (s, 1H, $-\text{CH}=\text{C}$), 7.83 [d, 2H, J = 9.02 Hz, Isatin-H (7)], 7.44 [t, 1H, J = 8.2 Hz, Isatin-H(6)], 7.27 [t, 1H, J = 5.8 Hz, Isatin-H(5)], 7.03 [d, 1H, J = 9.06 Hz, Isatin-H(4)], 3.89 (s, 3H, OCH_3) 2.76 (s, 3H, COCH_3). Calcd. for $\text{C}_{21}\text{H}_{15}\text{NO}_5$ (361.35); C, 69.80; H, 4.18; N, 3.87. Found: C, 69.90; H, 4.30; N, 3.80.

(3*E*)-1-Acetyl-3[5-(4-chlorophenyl)-2-oxofuran-3(2H)-ylidene]-1,3-dihydro-2H-indol-2-one (**1d**). Reddish-brown crystals 3.11 g, 85% yield, mp 216–217°C; IR (KBr pellet): 3431–3145 (br), for (NH); 1771 (s), for (C=O), 1610–1653 (m), (C=O), 1596 (m), (C=N) 1538 (C=C) cm^{-1} ; LRMS (EI): m/z 365 (M^+ , 25), 366 (8.5), 320 (5), 325 (22), 323 (11.5), 322 (82.22), 256 (7.20), 240 (3.34), 184 (20.03), 140 (19.5), 141 (34.45), 140 (10.93), 139.95 (100), 133 (10.17), 120 (17.3), 113 (25), 112 (12.11), 111 (52.5), 100 (10.17), 60 (57), 57 (70), 56 (34); GC: t_R = 1.89 min; column: DB-5 6 m $\times$ 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/5 min; ^1H NMR (CDCl_3 , 200 MHz): δ 9.05 [d, 2H, J = 8.06 Hz, $\text{Cl}-\text{C}_6\text{H}_4$ -(2)], 8.30 [d, 2H, J = 7.8 Hz, $\text{Cl}-\text{C}_6\text{H}_4$ -(3)],

8.05 (s, 1H, $-\text{CH}=\text{}$), 7.82 [d, 2H, $J = 6.8$ Hz, Isatin-H(7)], 7.60 [t, 1H, $J = 7$ Hz, Isatin-H(6)], 7.50 [t, 1H, $J = 7$ Hz, Isatin-H(4)], 7.23 [t, 1H, $J = 6.8$ Hz, Isatin-H(5)], 2.75 (s, 3H, $-\text{COCH}_3$). Calcd. for $\text{C}_{20}\text{H}_{12}\text{ClNO}_4$ (365.77): C, 65.67; H, 3.30; N, 3.82; Cl, 9.69; Found: C, 65.60; H, 3.40; N, 3.90; Cl, 9.50.

General Procedure for **2a–d**

To a suspension of **1a–d** (0.01 mol) in (25 ml) acetic acid, anthranilic acid (0.01 mol) was added and the reaction mixture was refluxed for 2 days, then cooled. The reddish solid precipitate was collected by filtration and recrystallized from acetic acid to give **2a–d**.

2-[[*(2E)*-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-4-oxo-4-phenylbutanoyl]amino]benzoic Acid (**2a**). Brown crystals 3.05 g, 65% yield, mp 125–127°C; IR (KBr pellet): 3423 (broad band) for (NH), 1686 (m) for (C=O), 1602 (v) for (C=O), 1550 (s), 1517 (s) for (C=N) cm^{-1} ; ^1H NMR (CDCl_3 , 200 MHz): δ 13.59 (bs, 1H, CO_2H), 8.88 (bs, 1H, CONH), 7.98–6.85 (m, 13H, Ar-H), 6.82 (s, 2H, $-\text{CH}_2-$), 2.78 (s, 3H, $-\text{COCH}_3$). Calcd. for $\text{C}_{27}\text{H}_{20}\text{N}_2\text{O}_6$ (468.46); C, 69.22; H, 4.30; N, 5.97; Found: C, 69.50; H, 4.50; N, 6.00.

2-[[*(2E)*-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-4(4-methylphenyl)-4-oxobutanoyl]amino]benzoic Acid (**2b**). Brown crystals 3.77 g, 78% yield, mp 175–177°C; IR (KBr pellet): 3250–3425 (broad band) for (OH and NH), 1770.3 (s) for (C=O), 1702 (m) for (C=O), 1611.5 (v) for (C=O), 1542.1 (s), and 1503 (s) for (C=N). cm^{-1} ; ^1H NMR (CDCl_3 , 200 MHz): δ 13.63 (bs, 1H, CO_2H), 8.9 (bs, 1H, CONH), 7.86 [d, 2H, $J = 9.06$ Hz, $\text{CH}_3-\text{C}_6\text{H}_4$ -(2)], 7.75–7.11 [m, 8H, Ar-H], 7.02 [d, 2H, $J = 9.06$ Hz, $\text{CH}_3-\text{C}_6\text{H}_4$ -(3)], 6.84 (s, 2H, $-\text{CH}_2-$), 2.75 (s, 3H, $-\text{COCH}_3$), 2.32 (s, 3H, $-\text{CH}_3$). Calcd. for $\text{C}_{28}\text{H}_{22}\text{N}_2\text{O}_6$ (482.49); C, 69.70; H, 4.59; N, 5.80; Found: C, 69.80; H, 4.50; N, 6.10.

2-[[*(2E)*-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-4(4-methoxyphenyl)-4-oxobutanoyl]amino]benzoic Acid (**2c**). Brown crystals 2.95 g, 59% yield, mp 270–272°C; IR (KBr pellet): 3018.4–3173.5 (bv) for (OH and NH), 1768.8 (v) for (C=O), 1694.1 (v) for (C=O), 1613.6 (v) for (C=O), 1544.6 (v), and 1502.9 (v) for (C=N) cm^{-1} ; LRMS (EI): m/z 440 ($\text{M}^+ - 58$), 1.3), 391 (2), 320 (19.4), 319 (80.81), 291 (7), 283 (5.45), 248 (7.50), 220 (5.89), 155 (25.7), 135 (100), 120 (20), 107 (12.7), 101 (20.77), 92 (35.73), 77 (20.44), 76 (10), 75 (12.94), 64 (12.2); GC: $t_R = 7.134$ min; column: DB-5 6 m $\times$ 0.01 mm + 1 m guard column: temp. prog:

50°C/2 min/20°C/1 min/250°C/10 min; ^1H NMR (CDCl_3 , 200 MHz): δ 13.62 (bs, 1H, CO_2H), 8.89 (bs, 1H, CONH), 7.98 (s, 1H, Ar-H), 7.86 [d, 2H, $J = 9.06$ Hz, $\text{CH}_3-\text{C}_6\text{H}_4$ -(2)], 7.68–7.09 [m, 7H, Ar-H], 7.02 [d, 2H, $J = 9.06$ Hz, $\text{CH}_3-\text{C}_6\text{H}_4$ -(3)], 6.85 [d, 1H, $J = 6.00$ Hz, Isatin-H(4)], 6.82 (s, 2H, $-\text{CH}_2-$), 3.89 (s, 3H, $-\text{OCH}_3$), 2.77 (s, 3H, $-\text{COCH}_3$). Calcd. for $\text{C}_{28}\text{H}_{22}\text{N}_2\text{O}_7$ (498.49); C, 67.46; H, 4.44; N, 5.61; Found: C, 67.90; H, 4.50; N, 6.00.

2-[[*(2E)*-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-4(4-chlorophenyl)-4-oxobutanoyl]amino]benzoic Acid (**2d**). Brown crystals 3.65 g, 72% yield, mp 245–247°C; IR (KBr pellet): 3419–3064 (broad band) for (OH and NH), 1705.4 (m) for (C=O), 1599.5 (m) for (C=O), 1545.6 (s), and 1486 (m) for (C=N) cm^{-1} ; LRMS (EI): m/z 505 (M^+ , 8), 442 (8.7), 384 (8.72), 383 (10.87), 296 (12), 256 (511.4), 234 (10), 210 (9), 191 (10), 190 (10), 156 (10), 148 (20.8), 140.95 (39.8), 139 (100), 134 (9.8), 132 (14), 129 (19.46), 128 (20), 111 (93.2), 75 (77.10); ^1H NMR (CDCl_3 , 200 MHz): δ 13.66 (bs, 1H, CO_2H), 8.88 (bs, 1H, CONH), 7.98 (s, 1H, Ar-H), 7.87 [d, 2H, $J = 9.06$ Hz, $\text{Cl}-\text{C}_6\text{H}_4$ -(2)], 7.68–7.09 [m, 6H, Ar-H], 7.02 [d, 2H, $J = 9.06$ Hz, $\text{Cl}-\text{C}_6\text{H}_4$ -(3)], 6.85 [d, 1H, $J = 6.00$ Hz, Isatin-H(4)], 6.82 (s, 2H, $-\text{CH}_2-$), 3.89 (s, 3H, $-\text{OCH}_3$), 2.11 (s, 3H, $-\text{COCH}_3$); GC: $t_R = 8.017$ min; column: DB-5 6 m $\times$ 0.01 mm + 1 m guard column: temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min. Calcd. for $\text{C}_{27}\text{H}_{19}\text{ClN}_2\text{O}_6$ (502.9); C, 64.48; H, 3.80; N, 5.57; Cl, 7.04; Found: C, 64.50; H, 3.70; N, 5.32; Cl, 7.70.

General Procedure for **2e–h**

To a suspension of **1a–d** (0.01 mol) in (25 ml) ethanol, *o*-phenylenediamine (0.01 mol) was added with refluxing for 3 h and then cooled. The brown precipitate was collected by filtration and recrystallized from ethanol to give **2e–h**.

(*2E*)-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-*N*-(2-aminophenyl)-4-oxo-4-phenylbutanamide (**2e**). Brown crystals 3.61 g, 82% yield, mp 263–264°C; IR (KBr pellet): 3452–3153, 3059.2 (broad band) for ($-\text{NH}$, $-\text{NH}_2$), 1745.6 (s), 1684.7 (v), for (C=O), 1606.1 (v) for (C=O), 1544.5 (s), and 1457.9 (s) for (C=N) cm^{-1} ; ^1H NMR (CDCl_3 , 200 MHz): δ 8.77 (bs, 2H, NH_2), 8.55 (bs, 1H, CONH), 8.30–6.96 (m, 13H, Ar-H), 6.94 (s, 2H, $-\text{CH}_2-$), 2.69 (s, 3H, $-\text{COCH}_3$). Calcd. for $\text{C}_{26}\text{H}_{21}\text{N}_3\text{O}_4$ (439.47); C, 71.05; H, 4.81; N, 9.56; Found: C, 71.20; H, 4.60; N, 9.90.

(2*E*)-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-*N*-(2-aminophenyl)-4-(4-methylphenyl)-4-oxobutanamide (**2f**). Brown crystals 3.85 g, 85% yield, mp 244–245°C; IR (KBr pellet): 3447.6, 3145.7, 3045, 3005.7 (broad band) for (–NH, –NH₂), 1745.6 (s), 1679.8 (v), for (C=O), 1608.7 (v) for (C=O), 1550.7 (s) for (C=N) cm^{–1}; ¹H NMR (CDCl₃, 200 MHz): δ 8.75 (bs, 2H, NH), 8.71 (bs, 1H, CONH), 8.45 (d, 2H, *J* = 7.8 Hz, CH₃–C₆H₄–(3)), 8.12 (d, 2H, *J* = 7.8 Hz, CH₃–C₆H₄–(2)), 7.18–6.96 (m, 8H, Ar-H), 5.94 (s, 2H, –CH₂), 2.51 (s, 3H, –COCH₃), 1.65 (s, 3H, –CH₃). Calcd. for C₂₇H₂₃N₃O₄ (453.50); C, 71.51; H, 5.11; N, 9.26; Found: C, 71.20; H, 5.10; N, 9.70.

(2*E*)-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-*N*-(2-aminophenyl)-4-(4-methoxyphenyl)-4-oxobutanamide (**2g**). Brown crystals 3.52 g, 75% yield, mp 232–234°C; IR (KBr pellet): 3449.3, 3165.5, 3091.2 (broad band) for (–NH, –NH₂), 1688.2 (v), for (C=O), 1608.0 (v) for (C=O), 1540.2 (s) for (C=N) cm^{–1}; LRMS (EI): *m/z* 469 (M⁺, 25.5), 468 (M⁺ – 1) 27.66, 400 (21.2), 399 (21), 371 (21), 360 (21), 349 (23), 348 (27), 307 (21), 305 (21), 301 (27), 291 (30), 283 (25), 283 (23), 275 (23), 251.7 (40), 251 (100), 230 (23), 222 (31), 216 (25), 206 (27), 174 (21), 171 (21), 170 (23), 185 (27), 180 (21), 159 (23), 151 (21), 149 (23), 129 (25), 100 (25), 90 (23), 72 (23), 59 (21); GC: *t*_R = 7.955 min; column: DB-5 6 m × 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min; ¹H NMR (CDCl₃, 200 MHz): δ 8.77 (bs, 2H, NH), 8.72 (s, 1H, CONH), 8.38 (d, 2H, *J* = 7.8 Hz, CH₃O–C₆H₄–(3)), 8.17 (d, 2H, *J* = 7.8 Hz, CH₃O–C₆H₄–(2)), 8.18–6.65 (m, 8H, Ar-H), 5.98 (s, 2H, –CH₂), 3.89 (s, 3H, –OCH₃), 1.61 (s, 3H, –COCH₃). Calcd. for C₂₇H₂₃N₃O₅ (469.50); C, 69.07; H, 4.93; N, 8.94; Found: C, 68.80; H, 4.70; N, 9.10.

(2*E*)-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-*N*-(2-aminophenyl)-4-(4-chlorophenyl)-4-oxobutanamide (**2h**). Brown crystals 3.8 g, 80% yield, mp 260–262°C; IR (KBr pellet): 3447.8, 3157.3, 3051.8 (broad band) for (–NH, –NH₂), 1679.6.2 (v), for (C=O), 1602.2 (v) for (C=O), 1582.2 (s), 1527.6 (s) for (C=N) cm^{–1}; LRMS (EI): *m/z* 476 (M⁺ – 2.5), 14), 445 (M⁺ – 28.5), 18), 443 (13), 398 (>5), 348 (>5), 299 (30), 298 (100), 270 (47), 255 (>5), 159 (47), 139 (72), 115 (44), 77 (42); GC: *t*_R = 9.438 min; column: DB-5 6 m × 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min; ¹H NMR (CDCl₃, 200 MHz): δ 8.96 (bs, 2H, NH), 8.88 (s, 1H, CONH), 8.42 (d, 2H, *J* = 8.8 Hz, Cl–C₆H₄–(3)), 8.15 (d, 2H, *J* = 8.8 Hz, Cl–C₆H₄–(2)), 8.12–6.77 (m, 8H, Ar-H), 6.34 (s, 2H, –CH₂), 1.77 (s, 3H, –COCH₃). Calcd. for C₂₆H₂₀ClN₃O₄ (473.91); C, 65.89; H, 4.25;

N, 8.86; Cl, 7.48; Found: C, 65.50; H, 4.10; N, 8.50; Cl, 7.80.

General Procedure for **3a–d**

A mixture of **1a,b,d** (0.01 mol) and sodium acetate (0.03 mol) was fused for 3 h, above melting point, then cooled. The reddish-brown solid was collected and recrystallized from ethanol to give **3a,b,d**. Compounds **3a–d** were obtained by mixing **2a–d** with freshly prepared sodium acetate (0.03 mol) at melting point for 2–5 h, and were found by direct comparison of analytical data to be identical.

2-[(3*E*)-3-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-5-phenyl-2-oxo-2,3-dihydro-1*H*-pyrrol-1-yl]benzoic Acid (**3a**). Reddish-brown crystals 3.13 g, 69% yield, mp >300°C; IR (KBr pellet): 3629.9–3407.1, 3059.0 (broad band) for (–OH), 1704.4 (s) for (C=O), 1660.6 (m), 1601.4 for (C=O) cm^{–1}; ¹H NMR (CDCl₃, 200 MHz): δ 13.59 (bs, 1H, CO₂H), 8.20–6.85 (m, 13H, Ar-H), 6.82 (s, 1H, –CH=C), 2.78 (s, 3H, –COCH₃). Calcd. for C₂₇H₁₈N₂O₅ (450.45); C, 71.99; H, 4.02; N, 6.21; Found: C, 72.30; H, 4.20; N, 6.00.

2-[(3*E*)-3-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-5-(4-methylphenyl)-2-oxo-2,3-dihydro-1*H*-pyrrol-1-yl]benzoic Acid (**3b**). Reddish-brown crystals 3.75 g, 80% yield, mp >300°C; IR (KBr pellet): 3425.8 (broad band) for (–OH), 1688.3 (s) for (C=O), 1593.8 (v) for (C=O) cm^{–1}; ¹H NMR (CDCl₃, 200 MHz): δ 13.55 (bs, 1H, CO₂H), 7.88 [d, 2H, *J* = 9.06 Hz, CH₃–C₆H₄–(2)], 7.75–7.09 [m, 8H, Ar-H], 7.02 [d, 2H, *J* = 9.06 Hz, CH₃–C₆H₄–(3)], 6.84 (s, 1H, –CH=C), 2.75 (s, 3H, –COCH₃), 2.32 (s, 3H, –CH₃). Calcd. for C₂₈H₂₀N₂O₅ (464.48); C, 72.40; H, 4.34; N, 6.03; Found: C, 72.30; H, 4.20; N, 6.20.

2-[(3*E*)-3-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-5-(4-methoxyphenyl)-2-oxo-2,3-dihydro-1*H*-pyrrol-1-yl]benzoic Acid (**3c**). To a suspension of **1d** (0.01 mol) in (25 ml) acetic acid, anthranilic acid (0.01 mol) was added with refluxing for 40 h, then cooled to solidify the product. The reddish-brown precipitate was collected by filtration and recrystallized from acetic acid to give a brown crystals 2.94 g, 61% yield, mp 263–265°C; IR (KBr pellet): 3230.3, 3118.8 (broad band) for (–OH), 1715 (s) for (C=O), 1685.3 (m), 1587.9 (s) for (C=O) cm^{–1}; LRMS (EI): *m/z* 450 (M⁺ – 30), >5), 319 (20), 200 (8), 235 (100), 170 (40), 137 (30); GC: *t*_R = 6.139 min; column: DB-5 6 m × 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min; ¹H NMR (CDCl₃, 200 MHz): δ 13.62 (bs, 1H,

CO₂H), 7.98 (s, 1H, Ar-H), 7.86 [d, 2H, $J = 9.06$ Hz, CH₃-C₆H₄-(2)], 7.82–7.12 [m, 8H, Ar-H], 7.10 [d, 2H, $J = 9.06$ Hz, CH₃-C₆H₄-(3)], 6.82 (s, 2H, -CH=C-), 3.89 (s, 3H, -OCH₃), 2.77 (s, 3H, -COCH₃). Calcd. for C₂₈H₂₀N₂O₆ (480.48); C, 69.99; H, 4.19; N, 5.83; Found: C, 69.90; H, 4.20; N, 6.10.

2-[(3*E*)-3-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-5-(4-chlorophenyl)-2-oxo-2,3-dihydro-1*H*-pyrrol-1-yl]benzoic Acid (**3d**). Reddish-brown crystals 3.40 g, 70% yield, mp >300°C; IR (KBr pellet): 3063.6–3402.6 (broad band) for (-OH), 1671.8.3 (s) for (C=O), 1597.1 (m) for (C=O) cm⁻¹; LRMS (EI): m/z 455 (M⁺ - 29.5), 66.5), 398 (85), 348 (>5), 397 (30), 396 (100), 395 (50), 331 (29), 251 (20), 205 (15), 146 (33.47); GC: $t_R = 9.028$ min; column: DB-5 6 m × 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min; ¹H NMR (CDCl₃, 200 MHz): δ 13.69 (bs, 1H, CO₂H), 7.87 [d, 2H, $J = 9.06$ Hz, Cl-C₆H₄-(2)], 7.98–7.09 [m, 7H, Ar-H], 7.02 [d, 2H, $J = 9.06$ Hz, Cl-C₆H₄-(3)], 6.85 [d, 1H, $J = 6.00$ Hz, Isatin-H(4)], 6.84 (s, 2H, -CH=C-), 3.89 (s, 3H, -OCH₃), 2.11 (s, 3H, -COCH₃). Calcd. for C₂₇H₁₇ClN₂O₅ (484.89); C, 66.88; H, 3.53; N, 5.77; Cl, 7.31; Found: C, 66.90; H, 3.70; N, 5.96; Cl, 6.90.

General Procedure for **3e–h**

A mixture of 2(3*H*)furanones **1a–d** (0.01 mol), *o*-phenylenediamine (0.01 mol), and freshly prepared sodium acetate (0.03 mol) was fused at melting point for 2–3 h, then cooled. The solid product was collected and recrystallized from ethanol to give **3e–h**, which was formed from the reaction of **2e–h** with freshly prepared sodium acetate (0.03 mol) at melting point for 2–5 h. Compounds **3e–h** were found by direct comparison (mp and mixed mp) and GC/MS spectral data to be identical in all aspects with the authentic products.

(3*E*)-1-Acetyl-3-[1-(2-aminophenyl)-5-phenyl-2-oxo-1,2-dihydro-3*H*-pyrrol-3-ylidene]-1,3-dihydro-2*H*-indol-2-one (**3e**). Brown crystals 2.55 g, 60% yield, mp 235–237°C; IR (KBr pellet): 3429.4 (broad band) for (NH₂), 1678.6 (s) for (C=O), 1600.9 (s), 1562.2 (v) for (C=O) cm⁻¹; ¹H NMR (CDCl₃, 200 MHz): δ 8.89 (bs, 2H, NH₂), 8.55–6.96 (m, 13H, Ar-H), 7.65 (s, 1H, -CH=C-), 2.70 (s, 3H, -COCH₃). Calcd. for C₂₆H₁₉N₃O₃ (421.45); C, 74.09; H, 4.54; N, 9.97; Found: C, 74.50; H, 4.70; N, 10.00.

(3*E*)-1-Acetyl-3-[1-(2-aminophenyl)-5-(4-methylphenyl)-2-oxo-1,2-dihydro-3*H*-pyrrol-3-ylidene]-1,3-dihydro-2*H*-indol-2-one (**3f**). Brown crystals 2.75 g,

63% yield, mp 279–281°C; IR (KBr pellet): 3431.6 (broad band) for (NH₂), 1687.9 (s) for (C=O), 1639.6 (s), 1561.6 (v) for (C=O) cm⁻¹; ¹H NMR (CDCl₃, 200 MHz): δ 8.75 (bs, 2H, NH), 8.55 (d, 2H, $J = 7.8$ Hz, CH₃-C₆H₄-(3)), 8.12 (d, 2H, $J = 7.8$ Hz, CH₃-C₆H₄-(2)), 7.18–6.96 (m, 8H, Ar-H), 7.94 (s, 1H, -CH=C-), 2.76 (s, 3H, -COCH₃), 1.65 (s, 3H, -CH₃). Calcd. for C₂₇H₂₁N₃O₃ (435.48); C, 74.46; H, 4.86; N, 9.64; Found: C, 74.50; H, 4.50; N, 9.50.

(3*E*)-1-Acetyl-3-[1-(2-aminophenyl)-5-(4-methoxyphenyl)-2-oxo-1,2-dihydro-3*H*-pyrrol-3-ylidene]-1,3-dihydro-2*H*-indol-2-one (**3g**). Reddish-brown crystals 2.53 g, 56% yield, mp >300°C; IR (KBr pellet): 3283.4, 3177.2, 3431.6 (broad band) for (NH₂), 1680.1 (s) for (C=O), 1601.6 (s), 1559.6 (v) for (C=O) cm⁻¹; LRMS (EI): m/z 330 (M⁺ - 121), >5), 298 (2.7), 295 (17.53), 291 (100), 277 (2.3), 255 (28), 251 (20), 250 (5.5), 223 (18), 187 (15), 186 (55.45), 160 (3.27), 159 (20), 131 (50), 76 (40); GC: $t_R = 7.260$ min; column: DB-5 6 m × 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min; ¹H NMR (CDCl₃, 200 MHz): δ 8.77 (bs, 2H, NH), 8.38 (d, 2H, $J = 7.8$ Hz, CH₃O-C₆H₄-(3)), 8.17 (d, 2H, $J = 7.8$ Hz, CH₃O-C₆H₄-(2)), 8.18–6.65 (m, 8H, Ar-H), 6.98 (s, 2H, -CH=C-), 3.89 (s, 3H, -OCH₃), 2.61 (s, 3H, -COCH₃). Calcd. for C₂₇H₂₁N₃O₄ (451.48); C, 71.82; H, 4.68; N, 9.30; Found: C, 71.70; H, 4.70; N, 9.50.

(3*E*)-1-Acetyl-3-[1-(2-aminophenyl)-5-(4-chlorophenyl)-2-oxo-1,2-dihydro-3*H*-pyrrol-3-ylidene]-1,3-dihydro-2*H*-indol-2-one (**3h**). Yellow crystals 2.65 g, 58% yield, mp 269–270°C; IR (KBr pellet): 3429.4, 3284.5, 3179.6 (broad band) for (NH₂), 1678.6 (s) for (C=O), 1601.8 (s), 1560.4 (v) for (C=O) cm⁻¹; LRMS (EI): m/z 463 (M⁺ - 7.5), 2.5), 301 (1.9), 348 (>5), 298 (10), 297 (3), 271 (8.33), 159 (11.75), 139 (40), 131 (40), 114 (10.5), 113 (35.39), 112 (10), 111 (100), 105 (11), 104 (20), 80 (20.7), 77 (30), 75 (80), 52 (23); GC: $t_R = 6.476$ min; column: DB-5 6 m × 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min; ¹H NMR (CDCl₃, 200 MHz): δ 8.98 (bs, 2H, NH), 8.72 (d, 2H, $J = 8.8$ Hz, Cl-C₆H₄-(3)), 8.15 (d, 2H, $J = 8.8$ Hz, Cl-C₆H₄-(2)), 8.71–6.77 (m, 8H, Ar-H), 7.84 (s, 1H, -CH=C-), 2.77 (s, 3H, -COCH₃). Calcd. for C₂₆H₁₈ClN₃O₃ (455.90); C, 68.49; H, 3.97; N, 9.21; Cl, 7.77; Found: C, 68.60; H, 4.10; N, 9.50; Cl, 8.00.

General Procedure for **4a–d**

To a suspension of **1a–d** (0.01 mol) in (25 ml) acetic acid, *o*-phenylenediamine (0.01 mol) was added in the presence of freshly prepared fused sodium acetate (0.03 mol). The reaction mixture was refluxed

for 5 h and then cooled. The yellowish precipitate was collected by filtration, washed with water, and recrystallized from acetic acid to give **4a–d**, which was formed from the reaction of **2e–h** with acetic acid/sodium acetate (0.03 mol) for 5 h at refluxing temperature. Compounds **4a–d** were found by direct comparison (mp and mixed mp) and GC/MS spectral data to be identical with the authentic products.

(3*E*)-1-Acetyl-3-[1-(1*H*-benzimidazol-2-yl)-3-phenyl-3-oxopropylidene]-1,3-dihydro-2*H*-indol-2-one (**4a**). Yellow crystals 2.07 g, 49% yield, mp 258–259°C; IR (KBr pellet): 3452.5–3142.1, 3052.2 (bm), 1686 (m), 1612.4 (v), for (C=O), 1554.4 (s), and 1507.3 (s) for (C=N) cm⁻¹; ¹H NMR (CDCl₃, 200 MHz): δ 9.78 (bs, 1H, NH), 8.70–6.96 (m, 13H, Ar-H), 6.94 (s, 2H, –CH₂), 2.69 (s, 3H, –COCH₃). Calcd. for C₂₆H₁₉N₃O₃ (421.45); C, 74.09; H, 4.54; N, 9.97; Found: C, 74.30; H, 4.20; N, 9.60.

(3*E*)-1-Acetyl-3-[1-(1*H*-benzimidazol-2-yl)-3-(methylphenyl)-3-oxopropylidene]-1,3-dihydro-2*H*-indol-2-one (**4b**). Yellow crystals 3.57 g, 82% yield, mp 241–242°C; IR (KBr pellet): 3446.1–3183.9, 3149.1 (bm), 1679.4 (m), 1608.5 (v), for (C=O), 1551.8 (s) for (C=N) cm⁻¹; ¹H NMR (CDCl₃, 200 MHz): δ 9.75 (bs, 1H, NH), 8.45 (d, 2H, *J* = 7.8 Hz, CH₃–C₆H₄-(3)), 8.22 (d, 2H, *J* = 7.8 Hz, CH₃–C₆H₄-(2)), 7.98–6.96 (m, 8H, Ar-H), 5.94 (s, 2H, –CH₂), 2.51 (s, 3H, –COCH₃), 1.69 (s, 3H, –CH₃). Calcd. for C₂₇H₂₁N₃O₃ (435.48); C, 74.46; H, 4.86; N, 9.64; Found: C, 74.00; H, 5.00; N, 9.00.

(3*E*)-1-Acetyl-3-[1-(1*H*-benzimidazol-2-yl)-3-(methoxyphenyl)-3-oxopropylidene]-1,3-dihydro-2*H*-indol-2-one (**4c**). Brown crystals 3.39 g, 75% yield, mp 238–240°C; IR (KBr pellet): 3038.7–2860.3 (bm), 1682.3 (v), 1597.7 (v), for (C=O), 1541.7 (s) for (C=N) cm⁻¹; LRMS (EI): *m/z* 453 (M⁺ + 2), 8), 340 (7.5), 321 (8.9), 311 (7), 295 (8), 294 (35), 265 (34), 235 (27), 224 (26), 221 (17), 193 (13), 187 (15), 185 (15), 158 (21), 152 (15), 151 (19), 135 (100), 130 (29.5), 121 (17), 115 (39), 114 (39), 107 (42), 105 (38), 102 (17), 92 (30), 90 (52), 97 (38), 85 (20), 76 (24), 71 (24), 85 (28), 83 (40), 82 (45), 54 (33), 51 (30); GC: *t*_R = 6.973 min; column: DB-5 6 m × 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/5 min.; ¹H NMR (CDCl₃, 200 MHz): δ 9.03 (bs, 2H, NH), 8.38 (d, 2H, *J* = 8.9 Hz, CH₃O–C₆H₄-(2)), 8.17 [(d, 2H, *J* = 8.9 Hz, CH₃O–C₆H₄-(3)], 8.18–6.65 (m, 8H, Ar-H), 6.97 (s, 2H, –CH₂), 3.89 (s, 3H, –OCH₃), 2.61 (s, 3H, –COCH₃) ppm; Anal. Calcd. for C₂₇H₂₁N₃O₄ (451.48); C, 71.82; H, 4.68; N, 9.30; Found: C, 71.50; H, 4.50; N, 9.40.

(3*E*)-1-Acetyl-3-[1-(1*H*-benzimidazol-2-yl)-3-(chlorophenyl)-3-oxopropylidene]-1,3-dihydro-2*H*-indol-2-one (**4d**). Brown crystals 3.6 g, 79% yield, mp 271–273°C; IR (KBr pellet): 3164.9–3089.3 (bm), 1689.2 (v), 1608.0 (v), for (C=O), 1538.5 (s) for (C=N) cm⁻¹; LRMS (EI): *m/z* 455 (M⁺), >5), 301 (10), 300 (10), 299 (14), 298 (83), 295 (11), 269 (40), 107 (27), 159 (42), 140 (32), 139 (100), 134 (10), 131 (33), 117 (27), 112 (23), 110 (75), 103 (20), 90 (23), 77 (30), 76 (24), 74 (40), 73 (15), 64 (13), 63 (15), 62 (25), 53 (11), 51 (27); GC: *t*_R = 7.215 min; column: DB-5 6 m × 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/5 min; ¹H NMR (CDCl₃, 200 MHz): δ 9.96 (bs, 2H, NH), 8.53 (d, 2H, *J* = 8.8 Hz, Cl–C₆H₄-(3)), 8.15 (d, 2H, *J* = 8.8 Hz, Cl–C₆H₄-(2)), 8.50–6.77 (m, 8H, Ar-H), 6.94 (s, 2H, –CH₂), 2.77 (s, 3H, –COCH₃). Calcd. for C₂₆H₁₈ClN₃O₃ (455.90); C, 68.49; H, 3.97; N, 9.21; Cl, 7.77; Found: C, 68.50; H, 4.00; N, 9.10; Cl, 7.80.

General Procedure for **6a–d**

To a suspension of **1a–d** (0.01 mol) in (25 ml) ethanol, *N*-aminophthalimide (0.01 mol) was added with refluxing for 3 h, then cooled. The reddish-brown precipitate was collected by filtration and recrystallized from ethanol to give **6a–d**.

(2*E*)-2(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-*N*-(1,3-dioxo-1,3-dihydro-2*H*-isoindol-2-yl)-4-phenyl-4-oxobutanamide (**6a**). Brown crystals 2.5 g, 50% yield, mp 158–160°C; IR (KBr pellet): 3340.7 (m), 3266.2 (m), 1783.6 (s), 1722.1 (v) for (C=O) and 1607.5 (s), 1543.4 (s) for (C=N) cm⁻¹; LRMS (EI): *m/z* 493 (M⁺), >5), 475 (M⁺ – 18), >5), 488 (>5), 381 (15), 288 (30), 261 (7), 216 (5), 106 (7), 105 (100), 76 (50); GC: *t*_R = 6.719 min; column: DB-5 6 m × 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min; ¹H NMR (CDCl₃, 200 MHz): δ 10.11 (s, 1H, NH), 8.34–7.25 [m, 13H, Ar-H), 4.20 (s, 2H, –CH₂), 2.77 (s, 3H, –COCH₃). Calcd. for C₂₈H₁₉N₃O₆ (493.47); C, 68.15; H, 3.88; N, 8.51; Found: C, 68.10; H, 3.90; N, 8.90.

(2*E*)-2(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-*N*-(1,3-dioxo-1,3-dihydro-2*H*-isoindol-2-yl)-4-(4-methylphenyl)-4-oxobutanamide (**6b**). Reddish-brown crystals 3.4 g, 67% yield, mp 120–122°C; IR (KBr pellet): 3427.5 (bv), 1722.2 (v), 1663.7 (s), for (C=O), 1615.1 (s) for (C=O) cm⁻¹; LRMS (EI): *m/z* 506 (M⁺ – 1), (>5), 399 (>5), 391 (>5), 337 (>5), 229 (>5), 173 (>5), 119 (100), 104 (10), 79 (10); GC: *t*_R = 6.950 min; column: DB-5 6 m × 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/5 min; ¹H NMR

(CDCl₃, 200 MHz): δ 10.52 (s, 1H, NH), 8.75 (d, 2H, $J = 7.8$ Hz, CH₃–C₆H₄–(2)), 8.12 (d, 2H, $J = 7.8$ Hz, CH₃–C₆H₄–(3)), 7.18–6.96 (m, 8H, Ar-H), 5.94 (s, 2H, –CH₂), 2.51 (s, 3H, –COCH₃), 1.65 (s, 3H, –CH₃). Calcd. for C₂₉H₂₁N₃O₆ (507.50); C, 68.63; H, 4.17; N, 8.27; Found: C, 69.00; H, 4.30; N, 8.70.

(2*E*)-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-*N*-(1,3-dioxo-1,3-dihydro-2*H*-isoindol-2-yl)-4-(4-methoxyphenyl)-4-oxobutanamide (**6c**). Brown crystals 2.1 g, 40% yield, mp 279–281°C; IR (KBr pellet): 3425.8 (bm), 3166.9 (bs), 3018.8 (bm), 2901.9 (bv), 1722.5 (s), 1661.6 (v) for (C=O), 1601.7 (s), 1560.4 (s), 1494.6 (v) for (C=O) cm⁻¹; LRMS (EI): m/z 554 (M⁺ + 1), >5), 371 (>5), 319 (>5), 248 (2), 220 (1), 162 (30.23), 161 (2), 135 (6), 132 (6), 118 (2), 106 (2.9), 105 (25), 104 (35), 102 (2), 101 (3), 92 (7), 91 (6), 77(89), 76 (84), 75 (53), 74 (88), 73 (22), 63 (19), 62 (19), 61 (20), 53 (40), 52 (23), 51 (100); GC: $t_R = 7.159$ min; column: DB-5 6 m $\times$ 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min; ¹H NMR (CDCl₃, 200 MHz): δ 10.72 (s, 1H, NH), 8.68 (d, 2H, $J = 7.8$ Hz, CH₃O–C₆H₄–(2)), 8.47 (d, 2H, $J = 7.8$ Hz, CH₃O–C₆H₄–(3)), 8.68–6.65 (m, 8H, Ar-H), 5.98 (s, 2H, –CH₂), 3.89 (s, 3H, –OCH₃), 1.61 (s, 3H, –COCH₃). Calcd. for C₂₉H₂₁N₃O₇ (523.50); C, 66.53; H, 4.04; N, 8.02; Found: C, 66.80; H, 4.10; N, 8.40.

(2*E*)-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-*N*-(1,3-dioxo-1,3-dihydro-2*H*-isoindol-2-yl)-4-(4-chlorophenyl)-4-oxobutanamide (**6d**). Reddish-brown crystals 3.2 g, 60% yield, mp 117–119°C; IR (KBr pellet): 3482.6 (bs), 3340.5 (m), 3265.9 (s), 1783.5 (s), 1721.8 (v) for (C=O), 1607.1 (s) for (C=O) cm⁻¹; LRMS (EI): m/z 526 (M⁺ – 1.5), 2.43), 514 (3), 503 (10), 502 (100), 55 (2.2), 125 (5), 96 (47), 95 (100), 79 (10), 78 (9), 65(23), 61 (47), 58 (27.77); GC: $t_R = 3.736$ min; column: DB-5 6 m $\times$ 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/5 min; ¹H NMR (CDCl₃, 200 MHz): δ 12.76 (s, 1H, NH), 7.88–7.42 [m, 12H, Ar-H], 4.21 (s, 2H, –CH₂), 2.76 (s, 3H, –COCH₃). Calcd. for C₂₈H₁₈ClN₃O₆ (527.92); C, 63.70; H, 3.43; N, 7.95; Cl, 6.71; Found: C, 64.10; H, 3.50; N, 8.00; Cl, 6.90.

2-[(3*E*)-3-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-5-phenyl-2-oxo-2,3-dihydro-1*H*-pyrrol-1-yl]-1*H*-isoindole-1,3(2*H*)-dione (**7a**). Equimolar amount of **1a** (0.01 mol) and *N*-aminophthalimide (0.01 mol) were mixed above melting point over 2 h and then cooled to solidify. The product obtained was recrystallized from ethanol to give a redish-brown crystal 2.2 g, 46% yield, mp 123–125°C; IR

(KBr pellet): 3427.8–3207.9 (broad band) for (OH), 1746.0 (bv) for (C=O), 1605.2.5 (s) for (C=O) cm⁻¹; ¹H NMR (CDCl₃, 200 MHz): δ 8.85–6.96 (m, 13H, Ar-H), 7.94 (s, 2H, –CH=C), 2.69 (s, 3H, –COCH₃). Calcd. for C₂₈H₁₇N₃O₅ (475.46); C, 70.73; H, 3.60; N, 8.83; Found: C, 70.50; H, 3.30; N, 8.50.

2-[(2-[(3*E*)-2-(1-Acetyl-2-oxo-1,2-dihydro-3*H*-indol-3-ylidene)-4-(4-methylphenyl)-4-oxobutanoyl]-hydrzino}-carbonyl-*N*-benzyl-benzamide (**8b**). To a suspension of **6b** (0.01 mol) in (10 ml) ethanol, benzylamine (0.01 mol) was added with stirring at room temperature for 24 h. The yellowish solid precipitate was collected by filtration and recrystallized from ethanol to give yellow crystal 3.81 g, 62% yield, mp >300°C; IR (KBr pellet): 3420.6 (br.), (NH), 3173.7, 3103.9 (–NH–NH–), 1718.7 (v) for (C=O), 1668.5 (v) for (C=O) cm⁻¹; LRMS (EI): m/z 304 [(M⁺ – 310), 8.8], 303 (35.23), 275 (21.31), 247 (5.9), 232 (9.11), 323 (11.5), 156 (15), 127 (10), 110 (24), 101 (26.2), 92 (10), 91 (100), 90 (24), 89 (37), 65 (35.94); GC: $t_R = 8.006$ min; column: DB-5 6 m $\times$ 0.01 mm + 1 m guard column; temp. prog: 50°C/2 min/20°C/1 min/250°C/10 min; ¹H NMR (CDCl₃, 200 MHz): δ 11.77–11.73 (bs, 2H, –NHNH–), 9.55 (s, 1H, CONH), 8.80–6.96 (m, 13H, Ar-H), 8.75 (d, 2H, $J = 7.8$ Hz, CH₃–C₆H₄–(2)), 8.53 (d, 2H, $J = 7.8$ Hz, CH₃–C₆H₄–(3)), 5.94 (s, 2H, –CH₂), 4.21 (s, 2H, –CH₂), 2.51 (s, 3H, –COCH₃), 1.65 (s, 3H, –CH₃). Calcd. for C₃₆H₃₀N₄O₆ (614.66); C, 70.34; H, 4.91; N, 9.11; Found: C, 69.90; H, 4.60; N, 9.00.

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