Novel and Simple Methodology for the Synthesis of 3-Acetylindoles and their N-Alkyl Derivatives Using TBAB as Phase Transfer Catalyst

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Abstract: Using 5% aq. NaOH, a simple method for the transformation of 3-cyanoacetylindoles **2(a-e)** into 3-acetylindoles **3 (a-e),** in good yields, is reported. Tetrabutylammoniumbromide (TBAB) is found to be an efficient phase transfer catalyst for the synthesis of N-alkyl derivatives **5(a-t)** of 3-acetylindoles **3(a-e)** giving products in excellent yields. **2 (a-e)** were themselves obtained from simple indoles **1 (a-e)** by reaction with cyano acetic acid in the presence of propionic anhydride at 100 ˚C for 5-10 min. Partial hydrolysis of **2 (a-e)** under hot acidic conditions yielded the corresponding carboxamides α-(3-indolecarboxoyl)acetamides **4(a-e).** Which could be readily transformed into the respective **3(a-e)** by refluxing with 5% aq. NaOH for 2-2.5 h.

Keywords: 3-cyanoacetylindole, 5% aq. NaOH, 3-acetylindole, alkylating agent, phase transfer catalyst (TBAB).

INTRODUCTION

Indole and its derivatives possess a wide range of biological activities and the chemistry of indoles has been reviewed by Gribble [1]. Acetylindoles are used as starting materials for the synthesis of carbazole [2], pyridocarbazole [3], carbolines [4] etc. several catalysts like $Si(O_2C\text{-}CH_2\text{-}CH_2\text{-}COOCH_3)_4$ / $SnCl_2$ [5] , $HClO_4$ [6], $SiCl_4$ [7] and $ZnCl_2$ [8] have been used for the acetylation of indoles. Okauchi *et al.* [9] reported that the indoles were converted into a metal derivative with Et_2AlCl or Me_2AlCl followed by treatment with acid chlorides to give acetyl indoles.

The synthesis of 3-acylindoles has been the subject of considerable interest not only because they are used as intermediates in alkaloid synthesis but also because they have useful biological activities [10]. Three major synthetic methods have been employed to prepare this class of compounds using indole as the starting material: (1) Acylation of the indole using Grignard reagents [11-14] (i.e. treatment of indole with EtMgI in dry ether followed by reaction with acetyl chloride producing 3-acetylindole) (2) acylation of N-protected indoles [15] and (3) the Vilsmeier-Haack reaction [11] (on simple and substituted indoles). There are also other methods based on acyl cation equivalents, such as nitrilium salts [16] and on dialkyl carbenium ions [17, 18]. Another method, using *N*-(R-haloacyl)pyridinium salts, gives predominantly 3-acylindoles under controlled conditions, but it seems to be restricted to some very reactive R-haloacyl halides [19]. Each of these methodologies has merits and shortcomings that limit their scope and yield.

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Although the 3-position is the most reactive site for electrophilic attack, [11] low yields encountered in this reaction are usually attributed to the competitive formation of 1-acylated and or 1, 3 diacylated products due to the ambident character of the indole system. Other side reactions, often observed in acidic conditions, are the self-polymerization of indole and the less common formation of di-indolylmethanes [20]. The use of N-protecting groups is generally the chosen strategy to overcome the concurrent formation of 1-acyl derivatives and to limit polymerization, which has not been observed when the indole system is deactivated by the presence of electron-withdrawing groups on the ring. Nevertheless, troublesome protection-deprotection steps are necessary in such situations [21, 22]. Additionally, the Vilsmeier-Haack reaction, involving amides and $POCl_3$, is not always effective, [12, 23, 24] providing only moderate yields and requiring the preparation of the amide if it is not commercially available.

RESULTS AND DISCUSSION

Herein we describe a novel and simple methodology for the synthesis of 3-acetylindoles **3 (a-e)** from 3-cyanoacetylindoles **2 (a-e)** in the presence of 5% aq. NaOH, through a very easy method that gives 3-acetylindoles in high yields without laborious work ups. Earlier it was reported from our lab [28] that the reaction of differently substituted indoles **1 (a-e)** with cyanoacetic acid in the presence of propionic anhydride under heating at 60-70˚C within 5-10 min gave different 3-cyanoacetylindoles **2(a-e)** in high yields (90-96 %) (Scheme **1**). Treatment of **2 (a-e)** with 5% aq. NaOH under reflux for 3-4 h, gave 3-acetylindoles **3(a-e)** in excellent yields (90-96 %) (Table **1**) (Scheme **1**).

In all cases, the reaction proceeds smoothly with 5 % aq. NaOH only. This method is very facile and convenient for the preparation of large amount of differently substituted 3-

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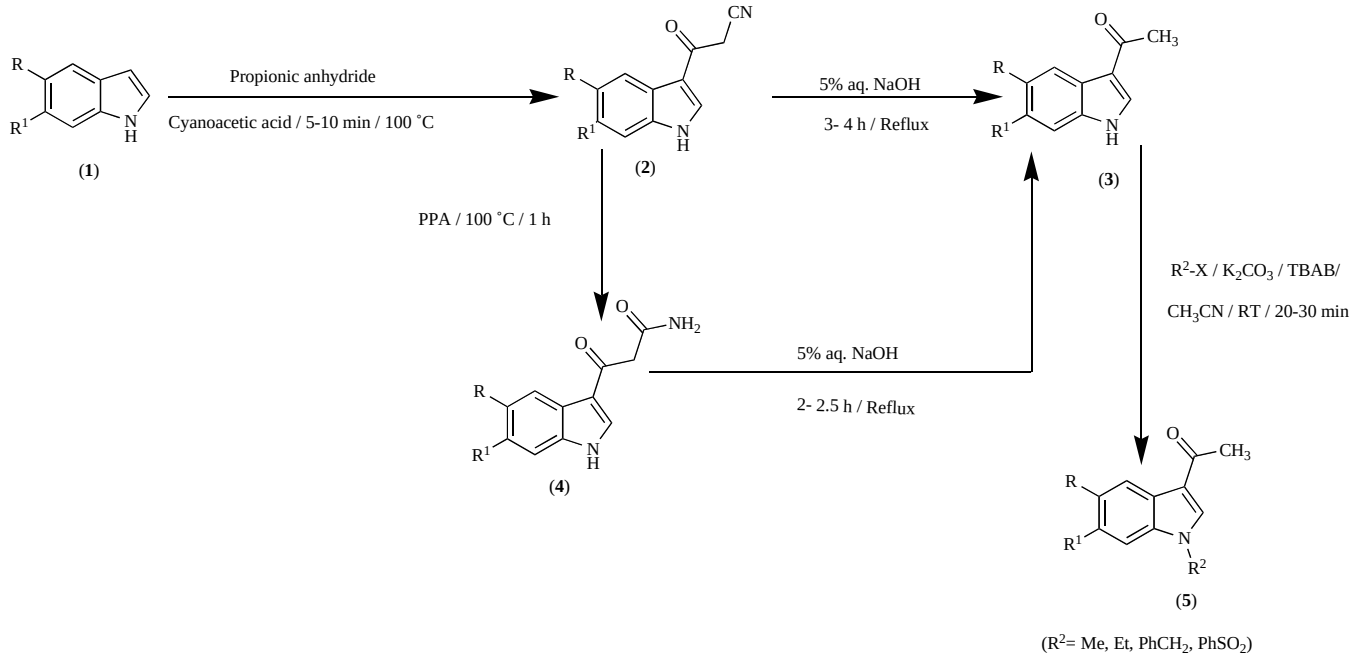


Scheme 1. Synthesis of 3-acetylindoles and N-Substituted 3-acetylindoles.

Table 1. Synthesis of 3 from 2 by Heating with 5% aq. NaOH

S.NO.	Substrate used	Time (hrs.)	Product obtained	Yield (%)	M.P (˚C)
1.	**2a**(R=H, R^1=H)	3.5 (Lit [26]: 10)	**3a**(R=H, R^1=H)	96 (Lit [26]: 78%)	186 (Lit [26]: 187)
2.	**2b**(R=OMe,R^1=H)	4	**3b**(R=OMe,R^1=H)	90	210
3.	**2c**(R=H, R^1=OMe)	4	**3c**(R=H,R^1=OMe)	92	214-15
4.	**2d**(R=Br, R^1=H)	3.5	**3d**(R=Br, R^1=H)	94	248
5.	**2e**(R=NO_2, R^1=H)	3.5	**3e**(R=NO_2, R^1=H)	95	>280

acetylindoles. The above reaction was attempted in the presence of various bases and acids like, 5%alc. NaOH, 5%alc. KOH, dil. HCl, dil. H_2SO_4 etc. but there was not much progress in this reaction. The rates of reactions in different basic and acidic media are described in Table **2**.

In the reaction mechanism shown in Scheme **2**, the HO^- ions attack the nitrile carbon yielding a nitrile anion which abstracts a proton from water giving the iminol intermediate **(2^I)**. The latter then tautomerises to form the amide **4** which undergoes hydrolysis by the common mechanism (shown above) giving the unstable ketoacid **4^I** that loses CO_2 to give **3,** a behavior typical of β-ketoacids.

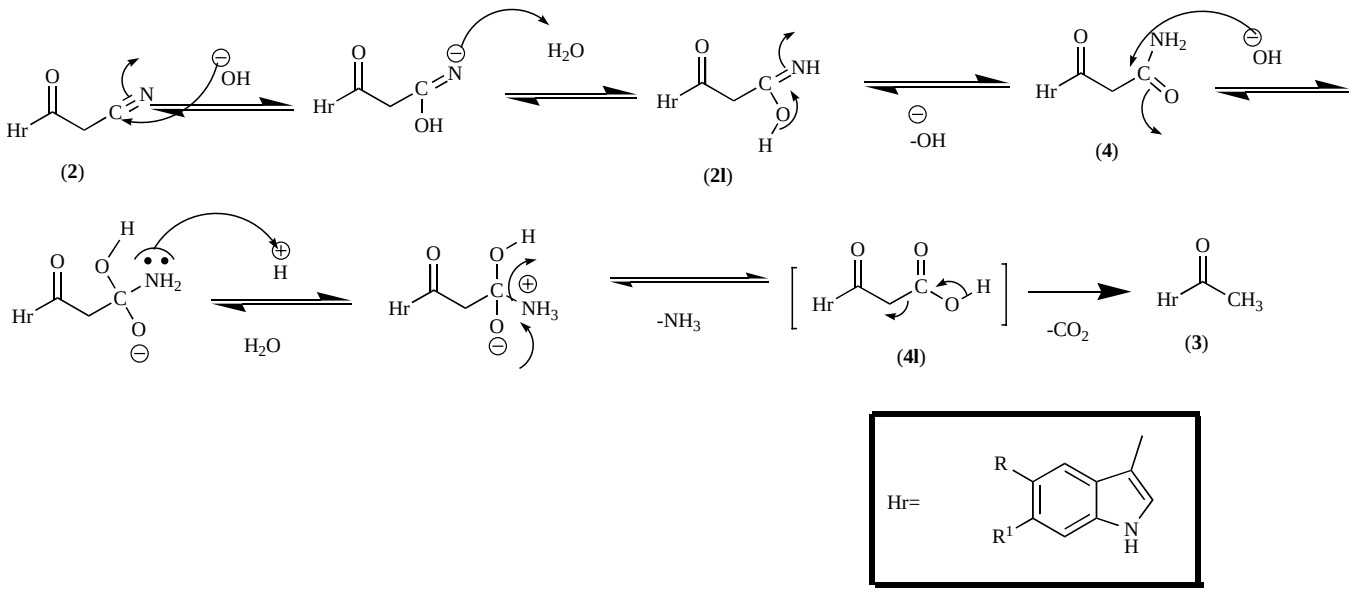
Alternatively, 3-acetylindoles **3(a-e)** could also be prepared from **4(a-e)** by the reaction of **2 (a-e)** with PPA at 100˚C for 1h, yielding the amide **4(a-e)** (Table **3**), followed by hydrolysis with 5% aq NaOH for 2-2.5 h giving **3(a-e)** in yields of 80-85% (Table **4**).

The reaction of **3(a-e)** with dimethylsulphate (DMS)), diethylsulphate (DES), benzyl chloride and benzenesulfonyl chloride in the presence of a weak base K_2CO_3 and catalytic amount of tetrabutylammonium bromide (TBAB) as phase transfer catalyst in a suitable solvent at room temperature for 15-30 min gave **5(a-t)** in high yields **(**Scheme **1) (**Table **5**). Acetonitrile seems to be the best choice among the solvents used for alkylation. The details of reactions done in different solvents are described in Table **6**.

In summary, the advantage of the procedure described herein over that of others is that N-alkylation and N-

Table 2. The Rates of the Reactions Carried Out in Different Basic and Acidic Media for Conversion of 2a to 3a

S. NO.	Substrate used	Reagent	Time (hrs.)	Temp (˚C)	Product obtained	Yield (%)
1	**2a**(R=R^1=H)	5% aq. NaOH	3.5-4	3.5-4	**3a**(R=R^1=H)	96
2	**2a**(R=R^1=H)	5% alc. NaOH	48	48	**3a**(R=R^1=H)	Nil
3	**2a**(R=R^1=H)	5% alc. KOH	48	48	**3a**(R=R^1=H)	Nil
4	**2a**(R=R^1=H)	dil.HCl	48	48	**3a**(R=R^1=H)	Nil
5	**2a**(R=R^1=H)	dil. H_2SO_4	24	24	**3a**(R=R^1=H)	Nil



Scheme 2. A plausible mechanism for the formation of **3** from **2**.

Table 3. Synthesis of 4 from 2 by Using PPA at 100 ˚C for 1 h

S. No.	Substrate used	Reaction Time (hrs.)	Product obtained	Yield (%)
1.	**2a**(R=H, R^1=H)	1	**4a**(R=H, R^1=H)	91
2	**2b**(R=OMe,R^1=H)	1	**4b**(R=OMe,R^1=H)	94
3.	**2c**(R=H, R^1=OMe)	1	**4c**(R=H, R^1=OMe)	89
4.	**2d**(R=Br, R^1=H)	1	**4d**(R=Br, R^1=H)	92
5.	**2e**(R=NO_2, R^1=H)	1	**4e**(R=NO_2, R^1=H)	95

Table 4. Alternative Synthesis of 3 from 4 by Using 5% aq. NaOH Reflux for 2-2.5 h

S. No.	Substrate used	Reaction Time (hrs.)	Product obtained	Yield (%)
1.	**4a**(R=H, R^1=H)	2	**3a**(R=H, R^1=H)	82
2.	**4b**(R=OMe,R^1=H)	2	**3b**(R=OMe,R^1=H)	81
3.	**4c**(R=H, R^1=OMe)	2	**3c**(R=H, R^1=OMe)	80
4.	**4d**(R=Br, R^1=H)	2	**3d**(R=Br, R^1=H)	83
5.	**4e**(R=NO_2, R^1=H)	2.5	**3e**(R=NO_2, R^1=H)	85

sufonylation of 3-acetylindole proceeds by a simple procedure without having tedious workup and high purity of the products under phase transfer catalytic conditions.

CONCLUSION

We have developed a simple and general method for the synthesis of 3-acetylindoles from 3-cyanoacetylindoles in the presence of 5% aq. NaOH. This reaction proceeds under mild conditions and is applicable to indoles bearing various functional groups without NH protection. Furthermore, the 3-acetylindoles could be smoothly alkylated to obtain 1-alky-3-acetylindoles using alkylating agents (DMS, DES, $C_6H_5CH_2Cl$ and benzenesulfonyl chloride) in acetonitrile using K_2CO_3 as a base and TBAB as phase transfer catalyst.

EXPERIMENTAL SECTION

Melting points were determined using a Buchi melting point B-545 apparatus and are uncorrected. TLC checking was done on glass plates coated with Silica Gel –G and spotting was done using iodine or UV lamp. IR spectra were recorded using Perkin Elmer model-446 FTIR in KBr.^{1}H-NMR spectra were recorded on a Gemini AV-400 instruments operating at 400 MHz.

General Procedure for the Preparation of 3 from 2

A mixture of aq. NaOH (5%, 20 ml) and **2** (10 mM) was refluxed for 3.5- 4 h. At the end of this period, the reaction mixture was cooled to rt. The separated solid was filtered,

Table 5. Synthesis of 5 from 3 by Using K_2CO_3/TBAB/CH_3CN/ RT/ Alkylating Agent

S.NO.	Substrate used	Reaction Time (min)	Product obtained	Yield (%)	M.P (˚C)
1.	**3a**(R=H, R^1=H)	20(Lit [27]: 180)	**5a**(R=H, R^1=H, R^2=Me)	94(Lit [27]: 85)	96 (Lit [25]: 95)
2.	**3b**(R=OMe,R^1=H)	30	**5b**(R=OMe,R^1=H, R^2=Me)	91	158-160
3.	**3c**(R=H, R^1=OMe)	25	**5c**(R=H,R^1=OMe, R^2=Me)	90	162-163
4.	**3d**(R=Br, R^1=H)	28	**5d**(R=Br, R^1=H, R^2=Me)	91	170-172
5.	**3e**(R=NO_2, R^1=H)	30	**5e**(R=NO_2, R^1=H, R^2=Me)	95	224
6.	**3a**(R=H, R^1=H)	28	**5f**(R=H, R^1=H, R^2=Et)	92	88 (Lit [25]: 89)
7.	**3b**(R=OMe,R^1=H)	30	**5g**(R=OMe,R^1=H, R^2=Et)	90	95
8	**3c**(R=H, R^1=OMe)	27	**5h**(R=H,R^1=OMe, R^2=Et)	92	125-126
9.	**3d**(R=Br, R^1=H)	31	**5i**(R=Br, R^1=H, R^2=Et)	94	133
10.	**3e**(R=NO_2, R^1=H)	30	**5j**(R=NO_2, R^1=H, R^2=Et)	96	217-218
11.	**3a**(R=H, R^1=H)	30	**5k**(R=H, R^1=H, R^2=$PhCH_2$)	92	80
12.	**3b**(R=OMe,R^1=H)	30	**5l**(R=OMe,R^1=H, R^2=$PhCH_2$)	90	123
13.	**3c**(R=H, R^1=OMe)	30	**5m**(R=H,R^1=OMe, R^2=$PhCH_2$)	91	142
14.	**3d**(R=Br, R^1=H)	30	**5n**(R=Br, R^1=H, R^2=$PhCH_2$)	95	118
15.	**3e**(R=NO_2, R^1=H)	30	**5o**(R=NO_2, R^1=H, R^2=$PhCH_2$)	96	180-182
16.	**3a**(R=H, R^1=H)	18	**5p**(R=H, R^1=H, R^2=$PhSO_2$)	98	245
17.	**3b**(R=OMe,R^1=H)	20	**5q**(R=OMe,R^1=H, R^2=$PhSO_2$)	94	>280
18.	**3c**(R=H, R^1=OMe)	20	**5r**(R=H,R^1=OMe, R^2=$PhSO_2$)	92	199-200
19	**3d**(R=Br, R^1=H)	19	**5s**(R=Br, R^1=H, R^2=$PhSO_2$)	94	>280
20.	**3e**(R=NO_2, R^1=H)	15	**5t**(R=NO_2, R^1=H, R^2=$PhSO_2$)	90	212

Table 6. The Alkylation of 3a to 5a in Different Solvents

Entry	Reagent	Time (min)	Temp	Yield (%)
1	K_2CO_3 / TBAB/ CH_3CN	15-30	RT	90-96
2	K_2CO_3 / TBAB/ $CHCl_3$	120	RT	75-80
3	K_2CO_3 / TBAB/ DMF	60	RT	63-68
4	K_2CO_3 / TBAB/ MeOH	240	RT	NIL
5	K_2CO_3 / TBAB/ Ethylacetate	180	RT	45-50
6	TBAB/ CH_3CN	300	RT	NIL

washed with water and dried to obtain crude **3** which on recrystallization from hot ethyl acetate gave pure **3**.

Alternative General Method for the Preparation of 3 from 4

A mixture of 5% aq. NaOH (20 ml) and **4** (10 mM) was refluxed for 2-2.5h. At the end of this period, the solid was separated from the reaction mixture. The separated solid was filtered, washed with water and dried to obtain the crude **3** which on recrystallization from hot ethyl acetate obtained pure **3**.

3a: Colorless solid; Yield = 1.52 gms (96%); m.p. 186-189 ˚C; IR (KBr): 3162 cm^{-1} (broad, medium, –NH) and 1631 cm^{-1} (strong, sharp, –CO); ^{1}H- NMR (DMSO-d_6/TMS) δ 2.48 (s, 3H, -C**H**$_3$), 7.14-7.21(m, 2H aryl protons of the indole ring)**,** 7.45-7.47 (m, 1H**,** aryl proton of the indole ring), 8.17-8.30 (m, 2H, one is aryl proton of the indole ring and one is α-proton of the indole ring), 11.93 (br s, 1H, D_2O exchangeable -N**H**); C^{13}- NMR (DMSO-d_6 /TMS): δ 27.6, 112.5, 117.3, 121.8, 122.1, 123.1, 125.7, 134.7 and 137.1 and 193.1; MS m/z = 160 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{10}H_9NO$ (159.06): C, 75.45 %; H, 5.70 %. Found: C, 75.47 %; H, 5.71 %.

3b: Colourless solid**;** Yield = 1.70 (90%); m.p. 210 ˚C; IR(KBr): 3172 cm^{-1} (broad, medium, –NH) and 1640 cm^{-1} (strong, sharp –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.41 (s, 3H, -C**H**$_3$), 3.75 (s, 3H, -OC**H**$_3$), 6.82 (q, J = 2.5 Hz, 1H), 7.34 (d, J = 8.7 Hz, 1H), 7.66 (d, J = 2.5 Hz, 1H), 8.23 (s, 1H, α-proton of the indole ring), 11.79 (br, 1H**,** D_2O-exchangeable -N**H**); MS m/z = 190($M^{+\cdot}$ +1); Anal. Calcd. for

$C_{11}H_{11}NO_2$ (189.21): C, 69.83 %; H, 5.86 %. Found: 69.79 %; H, 5.84 %.

3c: Colourless solid**;** Yield = 1.73 gms (92%); m.p. 214-215˚C; IR(KBr): 3162 cm^{-1} (broad, medium, –NH) and 1629 cm^{-1} (sharp, strong –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.42 (s, 3H, -C**H$_3$**), 3.78 (s, 3H, -OC**H$_3$**), 6.81- (q, J = 2 Hz, 1H), 6.94 (d, J = 2 Hz, 1H), 8.01-8.03 (d, J = 8.8 Hz, 1H), 8.17 (s, 1H, α-proton of the indole ring), 11.71 (br, 1H, D_2O-exchangeable -N**H**); MS m/z = 190($M^{+\cdot}$ +1); Anal. Calcd. for $C_{11}H_{11}NO_2$ (189.21): C, 69.83 %; H, 5.86 %. Found: 69.79 %; H, 5.84 %.

3d: Colourless solid**;** Yield = 2.37 gms (94%); m.p. 248˚C; IR(KBr): 3212 cm^{-1} (broad, medium, –NH) and 1636 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.47 (s, 3H, -C**H$_3$**), 7.14-7.21 (m, 2H), 7.46 (d, J = 7.1 Hz, 1H), 8.18-8.29 (m 2H), 11.92 (br, 1H, D_2O-exchangeable -N**H**); MS m/z = 238($M^{+\cdot}$ +1); Anal. Calcd. for $C_{10}H_8BrNO$ (236.99): C, 50.45 %; H, 3.39 %. Found: C, 50.47 %; H, 3.41 %.

3e: Light yellow solid**;** Yield = 1.93 gms (95%); m.p. >260˚C; IR(KBr): 3231 cm^{-1} (broad, medium, –NH) and 1641 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.48 (s, 3H, -C**H$_3$**), 7.63 (d, J = 8.9, 1H), 8.07 (m, J = 2.0 Hz, 1H), 8.55 (s, 1H), 8.99 (s, 1H, α-Proton of the indole ring) 12.4 (br, 1H, D_2O-exchangeable -N**H**); MS m/z = 205($M^{+\cdot}$ +1); Anal. Calcd. for $C_{10}H_8N_2O_3$ (204.04): C, 58.82%; H, 3.95 %. Found: C, 58.79 %; H, 3.98 %.

General Procedure for the Preparation of 4 from 2

2 (10mM) was added to PPA (15mL), and the resulting mixture was heated at 100 ˚C for 1 h, and then poured on to ice (≈100 gms). The precipitate formed was collected by filtration and washed with water to afford **4**. The crude product obtained above was recrystallized from methanol to give pure **4** as a solid.

4a: Light brown colour solid; Yield = 1.83 gms (91%); m.p. 207 ˚C; IR(KBr): 3192 cm^{-1} (broad, medium, –NH), 1645 cm^{-1} (sharp, strong, –CO) and 1606 cm^{-1} (strong, sharp, –$CONH_2$); ^{1}H- NMR (DMSO-d_6/TMS): δ 3.64-3.67 (s, 2H, -C**H$_2$**), δ 7.04 (b r s, 1H), δ 7.17-7.22 (m, 2H), δ 7.45-7.47 (m, 1H), δ 7.53 (br s, 1H), δ 8.14-8.16 (m, 1H), δ 8.33 (m, 1H), δ 12.02 (br s, 1H, D_2O-exchangeable -N**H**); MS m/z 203 ($M^{+\cdot}$ +1) Anal. Calcd. for $C_{11}H_{10}N_2O_2$ (202.05): C, 65.34 %; H, 4.98 %. Found. C, 65.32 %; H, 4.99 %.

4b: Grey coloured solid; Yield = 2.18 gms (94%); m.p. 139 ˚C; IR(KBr): 3194cm^{-1} (broad, medium, –NH), 1619cm^{-1} (sharp, strong, –CO) and 1519cm^{-1} (strong, –$CONH_2$); ^{1}H-NMR (DMSO-d_6/TMS): δ 3.65 (s, 2H, -C**H$_2$**), 3.78 (s**,** 3H, -OC**H$_3$**), 7.01 (br s, 1H), 7.21 (br s, 1H), 7.45 (m, 1H), 7.5-7.57 (m, 1H), 7.99-8.06 (m, 1H), δ 8.22-8.24 (m, 1H), 11.89 (br s, 1H, D_2O-exchangeable -N**H**); MS m/z = 233 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{12}H_{12}N_2O_3$ (232.01): C, 62.06 %; H, 5.21 %. Found: C, 62.09 %; H, 5.24 %.

4c: Off white solid; Yield = 2.06 gms (89%); m.p. 230-232 ˚C; IR(KBr): 3120 cm^{-1} (broad, medium, –NH), 1601cm^{-1} (sharp, strong, –CO) and 1516 cm^{-1} (sharp, strong, –$CONH_2$); ^{1}H- NMR (DMSO-d_6/TMS): δ 3.64 (s, 2H, -C**H$_2$**), 3.9 (s, 3H, -OC**H$_3$**), 6.81 (b r s, 1H), 6.94 (br s, 1H), 7.01 (m, 1H), δ 7.5-7.54 (m, 1H), 7.99-8.01 (m, 1H), 8.20-8.23 (m, 1H), 11.79 (br s, 1H, D_2O-exchangeable -N**H**); MS m/z = 233 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{12}H_{12}N_2O_3$ (232.01): C, 62.06 %; H, 5.21 %. Found: C, 62.09 %; H, 5.24 %.

4d: Brick red solid; Yield = 2.57 gms (92%); m.p. 208-210 ˚C; IR(KBr): 3226 cm^{-1} (broad, medium, –NH), 1603cm^{-1} (sharp, strong, -CO) and 1522cm^{-1} (sharp, strong, -$CONH_2$); ^{1}H- NMR (DMSO-d_6/TMS): δ 3.68 (s**,** 2H, -C**H$_2$**), 7.35 (b r s, 1H), 7.42 (br s, 1H), 7.44 (m, 1H), 7.46-7.54 (m, 1H), 8.29-8.35-8 (m, 1H), 8.35 (m, 1H), 12.19 (br s, 1H, D_2O-exchangeable -N**H**); MS m/z = 281 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{11}H_9BrN_2O_2$ (280.01): C, 47.00 %; H, 3.23 %. Found: C, 47.02 %; H, 3.24 %.

4e: light yellow solid; 2.34 (95%); m.p. 240-42 ˚C; IR(KBr): 3276 cm^{-1} (broad, medium, –NH), 1661 cm^{-1} (sharp, strong, -CO) and 1601 cm^{-1} (sharp, strong, –$CONH_2$); ^{1}H- NMR (DMSO-d_6/TMS): δ 3.60-3.64 (s, 2H, -C**H$_2$**), 7.18-7.21 (br, s, 1H), 7.34 (br, s, 1H), 7.48-7.50 (m, 2H), 7.52-7.56 (m, 1H), 8.20-8.22 (m, 1H), (m, 1H), δ 12.29 (br, s, 1H, D_2O-exchangeable -N**H**); MS m/z = 248 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{11}H_9N_3O_4$ (247.02): C, 53.44 %; H, 3.67 %. Found: C, 53.42 %; H, 3.69 %.

General Procedure for the Preparation of 5 from 3

A mixture of CH_3CN (20 ml), K_2CO_3 (2.07 gms, 15 mM), catalytic amount of TBAB (≈40 mg), **3** (10 mM) and alkylating agent (12 mM) was stirred at room temperature for 20-30 min. At the end of this period, the mixture was poured into water (≈ 100 ml). The separated solid was filtered, washed with water and dried to obtain the crude product which on recrystallization from hot ethyl acetate gave pure desired N-substituted-3-acetylindoles.

5a: Colourless solid; Yield = 1.62 gms (94%); m.p. 96˚C; IR(KBr): 1639cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.23-2.45 (s, 3H, -C**H$_3$**), 3.86 (s, 3H, N-C**H$_3$**), 7.18-26 (m, 2H), 7.47-7.49 (m, 1H), 8.14-8.16 (m, 1H), 8.24-8.25 (s, 1H, α-proton of the indole ring); MS m/z = 174(M+. +1); Anal. Calcd. for $C_{11}H_{11}NO$ (173.08); C, 76.28 %; H, 6.40 %. Found: C, 76.26 %; H, 6.38 %.

5b: Colourless solid**;** Yield = 1.84 gms (91%); m.p. 158-160 ˚C; IR(KBr): 1633 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.44 (s, 3H, -C**H$_3$**), 3.73 (s, 3H, -OC**H$_3$**), 3.91 (s, 3H, -N-C**H$_3$**), 6.81 (q, J = 2.5 Hz, 1H), 7.34 (d, J = 8.6 Hz, 1H), 7.66-7.67 (d, J = 2.5 Hz, 1H), 8.24 (s, 1H, α-proton of the indole ring); MS m/z = 204($M^{+\cdot}$ +1); Anal. Calcd. for $C_{12}H_{13}NO_2$ (203.06): C, 70.92 %; H, 6.45 %. Found: C, 70.98 %; H, 6.47 %.

5c: Colourless solid**;** Yield = 1.82 gms (90%); m.p. 162-163 ˚C; IR(KBr): 1631 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.41 (s, 3H, -C**H$_3$**), 3.71 (s, 3H, -OC**H$_3$**), 3.94 (s, 1H, -N-C**H$_3$**), 6.8 (q, J = 2.1 Hz, 1H), 6.93 (d, J = 2.1 Hz, 1H), 8.01-8.02 (d, J = 8.8 Hz, 1H), 8.19 (s, 1H, α-proton of the indole ring); MS m/z = 204 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{12}H_{13}NO_2$ (203.06): C, 70.92 %; H, 6.45 %. Found: C, 70.98 %; H, 6.47 %.

5d: Colourless solid**;** Yield = 2.29 gms (91%); m.p. 170-172˚C; IR(KBr): 1634 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.48 (s, 3H, -C**H$_3$**), 7.13-7.21 (m, 2**H**),

7.46-7.47 (d, J = 7.3 Hz, 1H), 8.18-8.23 (m 2H); MS m/z = 253($M^{+\cdot}$ +1); Anal. Calcd. for $C_{11}H_{10}BrNO$ (252.01): C, 52.41 %; H, 4.00 %. Found: C, 52.40 %; H, 4.02 %.

5e: Yellow solid**;** Yield = 2.08 gms (95%); m.p. 224˚C; IR(KBr): 1644 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.49 (s, 3H, -C**H$_3$**), 4.01 (s, 3H, -N-C**H$_3$**) 7.62 (d, J = 8.7, 1H), 8.06 (m, J = 2.0 Hz, 1H), 8.52 (s, 1H), 8.94 (s, 1H, α-Proton of the indole ring); MS m/z = 220($M^{+\cdot}$ +1); Anal. Calcd. for $C_{11}H_{10}N_2O_3$ (219.14): C, 60.55 %; H, 4.62 %. Found: C, 60.48 %; H, 4.64 %.

5f: Colourless solid**;** Yield = 1.72 gms (92%); m.p. 80˚C; IR(KBr): 1634 cm^{-1} (Sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 1.41 (t, J = 7.22, 3H, -C**H$_3$**), 4.26 (q, J = 7.2, 2H, -C**H$_2$**), 7.18-8.19 (m, 4H**,** aryl protons of the indole ring), 8.81 (s, 1H, α-proton of the indole ring); MS m/z = 186(M-1); Anal. Calcd. for $C_{12}H_{13}NO$ (187.21): C, 76.98 %; H, 7.00 %. Found: C, 76.96 %; H, 6.99 %.

5g: Colourless solid**;** Yield = 1.97 gms (90%); m.p. 80 ˚C; IR(KBr): 1633 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 1.42 (t, J = 7.1 Hz, 3H), 2.44 (s, 3H, -C**H$_3$**), 3.71 (s, 3H, -OC**H$_3$**), 3.91 (s, 3H, -N-C**H$_3$**), 4.3 (q, J = 7.1 Hz, 2H), 6.82 (q, J = 2.5 Hz, 1H), 7.36 (d, J = 8.6 Hz, 1H), 7.67-7.68 (d, J = 2.5 Hz, 1H), 8.26 (s, 1H, α-proton of the indole ring); MS m/z = 218 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{13}H_{15}NO_2$ (217.10): C, 71.87 %; H, 6.96 %. Found: C, 71.90 %; H, 6.99 %.

5h: Colourless solid**;** Yield = 1.99 gms (92%); m.p. 125-126˚C; IR(KBr): 1630 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 1.30 (t, J = 7.0 Hz, 3H), 2.42 (s, 3H, -C**H$_3$**), 3.61 (s, 3H, -OC**H$_3$**), 3.94 (s, 1H, -N-C**H$_3$**), 4.2 (q, J = 7.0 Hz, 2H), 6.6 (q, J = 2.2 Hz, 1H), 6.94 (d, J = 2.2 Hz, 1H), 8.04 (d, J = 8.6 Hz, 1H), 8.19 (s, 1H, α-proton of the indole ring); MS m/z = 218 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{13}H_{15}NO_2$ (217.10): C, 71.87 %; H, 6.96 %. Found: C, 71.90 %; H, 6.99 %.

5i: Grey coloured solid**;** Yield = 2.49 gms (94%); m.p. 126˚C; IR(KBr): 1633 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 1.27 (t, J = 7.1 Hz, 3H), 2.46 (s, 3H, -C**H$_3$**), 4.31 (q, j = 7.1 Hz, 2H), 7.12-7.19 (m, 2H), 7.45-7.47 (m 1H), 8.19-8.24 (m, 2H**,** one is α-proton of the indole ring + one is aryl proton of the indole ring); MS m/z = 266 ($M^{+\cdot}$ +1) Anal. Calcd. for $C_{12}H_{12}BrNO$ (265.00): C, 54.16 %; H, 4.54 %. Found: C, 54.13 %; H, 4.56 %.

5j: Light yellow solid**;** Yield = 2.22 gms (96%); m.p. 217-218˚C; IR(KBr): 1641 cm^{-1} (sharp, strong, –CO); ^{1}H-NMR (DMSO-d_6/TMS): δ 1.30 (t, J = 7.1 Hz, 3H), 2.47 (s, 3H, -C**H$_3$**), 4.43 (q, J = 7.1 Hz, 2H), 7.62 (m, 1H), 8.07 (m, 1H), 8.32 (s, 1H), 8.99 (s, 1H, α-Proton of the indole ring); MS m/z = 233 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{12}H_{12}N_2O_3$ (232.08): C, 62.06 %; H, 5.21 %. Found: C, 62.04 %; H, 5.19 %.

5k: Colourless solid; Yield = 2.29 gms (92%); m.p. 80 ˚C; IR(KBr): 1614 cm^{-1} (sharp, strong, –CO)**;** ^{1}H- NMR (DMSO-d_6/TMS): δ 2.45 (s, 3H, -C**H$_3$**)**,** 5.42-5.46 (s, 2H, N-C**H$_2$**)**,** 7.2-8.2 (m, 9H, four aryl protons of the indole ring + five aromatic protons), 8.58-8.60 (s, 1H**,** α-proton of the indole ring); MS m/z= 250($M^{+\cdot}$ +1); Anal. Calcd. for $C_{17}H_{15}NO$ (249.11): C, 81.90 %; H, 6.06 %. Found: C, 81.93 %; H, 6.05 %.

5l: Colourless solid**;** Yield = 2.51 gms (90%); m.p. 123˚C; IR(KBr): 1614 cm^{-1} (sharp, strong, -CO)**;** ^{1}H- NMR (DMSO-d_6/TMS): δ 2.44 (s, 3H, -C**H$_3$**)**,** 3.72 **(**s, 3H, O-C**H$_3$**)**,** 5.40 (s, 2H, N-C**H$_2$**)**, 7.23-8.23 (m, 9H, four aryl protons of the indole ring + five aromatic protons), 8.51 (s, 1**H,** α-proton of the indole ring); MS m/z = 280 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{18}H_{17}NO_2$ (279.10): C, 77.40 %; H, 6.13 %. Found: C, 77.42 %; H, 6.14 %.

5m: Colourless solid**;** Yield = 2.53 gms (91%); m.p. 142 ˚C; IR(KBr): 1625 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.47 (s, 3H, -C**H$_3$**), 3.64 (s, 3H, -OC**H$_3$**), 5.10 (s, 2H, N-C**H$_2$**)**,** 7.23-8.12 (m, 9H, four aryl protons of the indole ring + five aromatic protons) 8.49 (s, 1**H**, α-proton of the indole ring); MS m/z = 280 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{18}H_{17}NO_2$ (279.10): C, 77.40; H, 6.13. Found: C, 77.42 %; H, 6.14 %.

5n: Colourless solid**;** Yield = 3.09 gms (95%); m.p. 118˚C; IR(KBr): 1646 cm^{-1} (sharp, strong, –CO); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.37 (s, 3H, -C**H$_3$**), 5.43 (s, 2H, N-C**H$_2$**)**,** 7.33-8.31 (m, 9H, four aryl protons of the indole ring + five aromatic protons) 8.53 (s, 1**H**, α-proton of the indole ring); MS m/z = 328 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{17}H_{14}BrNO$ (327.01): C, 62.21 %; H, 4.30 %. Found: C, 62.19 %; H, 4.32 %.

5o: Light yellow solid**;** Yield = 2.82 gms (96%); m.p. 180-182˚C; IR(KBr): 1643 cm^{-1} (sharp, strong, –CO); ^{1}H-NMR (DMSO-d_6/TMS): δ 2.67 (s, 3H, -C**H$_3$**), 5.56 (s, 2H, N-C**H$_2$**)**,** 7.31-8.36 (m, 9H, four aryl protons of the indole ring + five aromatic protons) 8.61 (s, 1H, α-proton of the indole ring); MS m/z = 295 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{17}H_{14}N_2O$ (294): C, 69.38 %; H, 4.79 %. Found: C, 69.44 %; H, 4.81 %.

5p: Colourless solid; Yield = 2.93 gms (98%); m.p: > 245 ˚C; IR(KBr) 1688 cm^{-1} (sharp, strong, –CO), and a strong unequal doublet at 1170 and 1140 cm^{-1} (due to $–SO_2$); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.4-2.5(s, 3H, -C**H$_3$**), 7.31-8.17(m, 9H, five phenyl an+ four aryl protons of the indole ring), 8.8 (s, 1**H**, α-proton of the indole ring); MS m/z: 300 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{16}H_{13}NO_3S$ (299.02): C, 64.20 %; H, 4.38 %. Found: C, 64.18 %; H, 4.37 %.

5q: Grey coloured solid; Yield = 3.09 games (94%); m.p**.** > 280 ˚C; IR (KBr) 1691 cm^{-1} (sharp, strong, –CO), and a strong unequal doublet at 1169 and 1114 cm^{-1} (due to $–SO_2$); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.62 (s, 3H, -C**H$_3$**), 3.76 (s, 3H, -OC**H$_3$**), 7.36-8.21 (m, 8H, five phenyl + three aryl protons of the indole ring), 8.73 (s, 1H, α-proton of the indole ring); MS m/z: 330 ($M^{+\cdot}$ +1); Anal. Calcd. For $C_{17}H_{15}NO_4S$ (329.02): C, 61.99 %; H, 4.59 %. Found: C, 62.01 %; H, 5.00 %.

5r: Colourless solid; Yield = 3.02 gms (92%); m.p**.** 199-200 ˚C; IR (KBr) 1696 cm^{-1} (sharp, strong, –CO), and a strong unequal doublet at 1170 and 1116 cm^{-1} (due to $–SO_2$); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.62 (s, 3H, -C**H$_3$**), 3.74 (s, 3H, -OC**H$_3$**), 7.30-8.19 (m, 8H, five phenyl + three aryl protons of the indole ring), 8.70 (s, 1H, α-proton of the indole ring); MS m/z: 330 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{17}H_{15}NO_4S$ (329.02): C, 61.99 %; H, 4.59 %. Found: C, 62.01 %; H, 5.00 %.

5s: Ash Coloured solid**;** Yield = 3.40 gms (94%); m.p. > 280 ˚C; IR (KBr) 1699 cm^{-1} (sharp, strong, –CO), and a strong unequal doublet at 1174 and 1117 cm^{-1} (due to $–SO_2$); ^{1}H- NMR (DMSO-d_6/TMS): δ 2.60 (s, 3H, -C**H$_3$**), 7.28-8.12 (m, 8H, five phenyl an+ three aryl protons of the indole ring), 8.53 (s, 1H, α-proton of the indole ring); MS m/z: 378 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{16}H_{12}BrNO_3S$ (376.98): C, 50.81 %; H, 3.20 %. Found: C, 50.79 %; H, 3.22 %.

5t: Light yellow solid; Yield = 3.09 gms (90%); m.p. 212 ˚C; IR (KBr) 1695 cm^{-1} (sharp, strong, –CO), and a strong unequal doublet at 1170 and 1114 cm^{-1} (due to $–SO_2$); ^{1}H-NMR (DMSO-d_6/TMS): δ 2.63 (s, 3H, -C**H$_3$**), 7.19-8.19 (m, 8H, five phenyl an+ three aryl protons of the indole ring), 8.60 (s, 1H, α-proton of the indole ring); MS m/z: 345 ($M^{+\cdot}$ +1); Anal. Calcd. for $C_{16}H_{12}N_2O_5S$ (344.01): C, 55.81 %; H, 3.51 %; C, 55.83 %; H, 3.53 %.

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