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Vilsmeier-Haack Reaction with 2,3,3-Trimethyl-3*H*-benzo[*g*]indole and Its Conversion into 2-(1-aryl-1*H*-pyrazol-4-yl)-3,3-dimethyl-3*H*-benzo[*g*]indoles

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Vilsmeier-Haack reaction of 2,3,3-trimethyl-3*H*-benzo[*g*]indole, then aqueous basic work-up, leads to benzo[g]indol-2-ylidene-malondialdehydes. These react with various arylhydrazines and quinolin-2-ylhydrazine to form 3,3-dimethyl-2-(1-aryl-1*H*-pyrazol-4-yl)-3*H*-benzo[*g*]indoles in good yields.

Keywords: Vilsmeier-Haack reaction, Formylation, Pyrazole, Malondialdehyde, 2-Quinolylhydrazine, Arylhydrazine

INTRODUCTION

The Vilsmeier-Haack reaction is a convenient method for the formylation of activated aromatic and heteroaromatic compounds [1]. Meth-Cohn and co-workers have extensively explored the usefulness of chloromethylene-iminium salts (Vilsmeier-Haack reagent) in the synthesis of heterocycles [2-4]. Perumal and co-workers have reported various interesting cyclisation reactions under Vilsmeier condition [5-7].

Reactions of aliphatic alkenes with chloromethylene-iminium salts are often accompanied by multiple iminoalkylations leading to the formation of conjugated polyenaldehydes as final products [8,9]. As early as 1966, Jutz *et al*. [10] demonstrated that the intermediate iminium salts formed from 2-phenylpropene and isobutene can cyclise to substituted pyridine or naphthyridine, respectively, in the presence of ammonium acetate. The compounds included an active methylene or methyl group that was formylated under Vilsmeier reaction condition [11-13].

Previously, [14-18], we described the reactions of several 2,3,3-trimethylindolenines(2,3,3-trimethyl-3*H*-indoles) **1a,b** with the Vilsmeier reagent formed from *N*,*N*-dimethylformamide and phosphoryl trichloride to produce aminomethylene malondialdehydes **2a,b** (indol-2-ylidene-malondialdehydes). Additionally we showed that the pyridoindolenines **4a,b** behave similarly, forming aminomethylene malondialdehydes **5a,b**. The condensation of hydrazine or aryl hydrazines with the aminomethylene malondialdehydes **2a,b** and **5a,b** afforded the corresponding 4-substituted pyrazoles **3a,b** and **6a,b** (Scheme 1).

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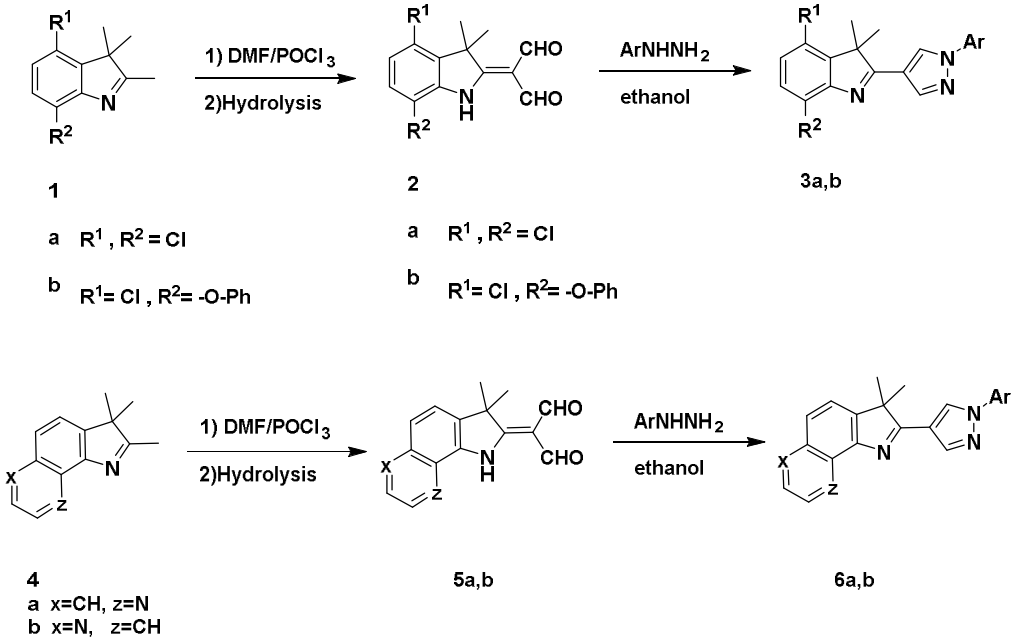
EXPERIMENTAL

Melting points were measured on an electrothermal IA9200 apparatus. ^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker Avance AQS 300 MHz spectrometer, at 300 MHz and 75 MHz, respectively. Chemical shifts δ are in parts per million (ppm) measured in $CDCl_3$ as solvent and related to TMS as the internal standard. IR spectra were recorded on a Thermonicolet-Nexus 670 FT-IR instrument. Elemental analyses were performed on Heraeus CHN-O rapid analyzer.

2,3,3-Trimethyl-3*H*-benzo[*g*]indole (7). A mixture of 1-naphthylhydrazinium chloride (8 g, 41 mmol) and isopropyl methyl ketone (3.7 ml, 40 mmol) in acetic acid (25 ml) was refluxed for 10 h. After cooling the mixture, it was diluted with water (50 ml) and pH of the solution brought to 8 by addition of $NaOH_{(aq.)}$ (2 M). Next, the alkaline solution was extracted with ethyl acetate (4 × 50



Scheme 1

ml). The organic layer was dried over Na_2SO_4 and concentrated to dryness in *vacuo* to yield 5.6 g (65%) of a brown powder which was crystallized from ethanol, m.p.: 110-112 °C, FT-IR (KBr) ν_{max} (cm^{-1}): 3050, 2961, 2925, 1632, 1582, 1361, 815; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.41 (s, 6H), 2.49 (s, 3H), 7.47 (d, J = 8.4 Hz, 1H, H-4), 7.51 (ddd, J_1 = 8.1 Hz, J_2 = 6.9 Hz, J_3 = 1.2 Hz, 1H, H-7), 7.61 (ddd, J_1 = 8.1, J_2 = 6.9 Hz, J_3 = 1.2 Hz, 1H, H-8), 7.78 (d, J = 8.4 Hz, 1H, H-5), 7.90 (d, J = 8.1 Hz, 1H, H-6), 8.84 (d, J = 8.1 Hz, 1H, H-9); ^{13}C NMR ($CDCl_3$): δ (ppm) 15.5, 22.70, 54.7, 119.3, 121.9, 123.3, 125.6, 125.6, 126.3, 126.6, 128.0, 133.7, 141.7, 188.6; Anal. Calcd. for: C, 86.08%; H, 7.22%; N, 6.69%. Found: C, 85.78%; H, 7.14%; N, 6.68%.

2-(3,3-Dimethyl-1,3-dihydro-2*H*-benzo[*g*]indol-2-ylid ene)propanedial (8). To *N*,*N*-dimethyl-formamide (8 ml, 104 mmol) cooled in an ice bath was added dropwise phosphoryl trichloride (5.5 ml, 60 mmol) with stirring at below 5 °C. Next, 3*H*-indole **7** (4.6 g, 21 mmol) was added slowly. The cooling bath was removed and the reaction mixture was stirred at 75 °C for 10 h. The resulting solution was added to ice-cooled water and made alkaline with NaOH (aq.) solution (pH = 8-9). The resulting precipitate was collected by filtration, dried in air and crystallized from ethanol to give orange crystals. Yield: 4.68 g (84%); m.p.: 150-152 °C; FT-IR (KBr) ν_{max} (cm^{-1}): 3113, 2923, 2851, 1678, 1596, 1575, 1169, 819, 769. ^{1}H NMR ($CDCl_3$): δ (ppm), 1.84 (s, 6H), 7.48 (d, J = 8.4, 1H, H-4), 7.54 (ddd, J_1 = 8.4 Hz, J_2 = 6.9 Hz, J_3 = 1.2 Hz, 1H, H-7), 7.62 (ddd, J_1 = 8.4 Hz, J_2 = 6.9 Hz, J_3 = 1.2 Hz, 1H, H-8), 7.79 (d, J = 8.4 Hz, 1H, H-5), 7.9 (d, J = 8.4 Hz, 1H, H-6), 7.98 (d, J = 8.4 Hz, 1H, H-9), 9.80 (s, 1H, CHO), 9.85 (s, 1H, CHO), 14.30 (bs, 1H, NH); ^{13}C NMR ($CDCl_3$): δ (ppm) 22.8, 52.1, 110.0, 112.7, 116.5, 119.4, 120.7, 124.0, 126.2, 126.5, 127.3, 128.8, 133.5, 187.8, 192.6; Anal. Calcd. for: C, 76.96%; H, 5.70%; N, 5.28%. Found: C, 76.82%; H, 5.63%; N, 5.41%.

General procedure for synthesis of (9a-h). A mixture of the malondialdehyde **8** (0.12 g, 0.45 mmol) and aryl hydrazinium chloride (0.45 mmol), in absolute ethanol (15 ml) was heated at reflux and stirred for 2-5 h. After cooling, the solution was diluted with water (20 ml) and the pH was adjusted to 7-8 using $NaOH_{(aq.)}$ (2 M). The resulting crystals were collected by filtration and recrystallized from ethanol to give the corresponding pyrazoles.

3,3-Dimethyl-2-(1*H*-pyrazol-4-yl)-3*H*-benzo[*g*]indole (9a). Yellow crystals; IR (KBr, cm^{-1}): ν 3166, 3051, 2963, 1632, 1566, 938, 814; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.60 (s, 6H), 7.51 (m, 2H, H-4 & H-7), 7.60 (t, J = 8.4 Hz, 1H, H-8), 7.77 (d, J = 8.1, 1H, H-5), 7.90 (d, J = 8.1, 1H, H-6), 8.67 (d,

J = 8.4, 1H, H-9), 8.35 (s, 2H, pyrazole), 12-14 (bs, NH); ^{13}C NMR ($CDCl_3$): δ (ppm) 24.3, 54.3, 119.0, 119.4, 121.3, 123.5, 125.1, 125.5, 125.6, 126.1, 128.0, 128.6, 133.8, 134.1, 142.4, 179.0; Anal. Calcd. for $C_{17}H_{15}N_3$: C, 78.13%; H, 5.79%; N, 16.08%. Found: C, 77.75%; H, 5.60%; N, 15.74%.

3,3-Dimethyl-2-(1-phenyl-1*H*-pyrazol-4-yl)-3*H*-benzo [*g*]indole (9b). Brown crystals; IR (KBr, cm^{-1}): ν 3075, 2964, 2930, 1610, 1584, 1261, 947, 750. ^{1}H NMR ($CDCl_3$): δ (ppm) 1.81 (s, 6H), 7.45 (d, *J* = 7.5 Hz, 1H), 7.54-7.56 (m, 4H), 7.80 (t, *J* = 8.4 Hz, 1H), 7.94-7.98 (m, 4H), 9.45 (d, *J* = 6.9 Hz, 1H), 8.49 (s, 1H, pyrazole), 10.85 (s, 1H, pyrazole); ^{13}C NMR ($CDCl_3$): δ (ppm) 25.6, 53.4, 111.5, 118.1, 119.9, 122.9, 124.6, 127.5, 128.2, 128.8, 128.9, 129.7, 129.9, 133.9, 135.5, 136.4, 138.3, 139.4, 141.9, 179.1; Anal. Calcd. for $C_{23}H_{19}N_3$: C, 81.87%; H, 5.68%; N, 12.45%. Found: C, 81.60%; H, 5.42%; N, 12.59%.

2-(1-(2-Chlorophenyl)-1*H*-pyrazol-4-yl)-3,3-dimethyl -3*H*-benzo[*g*]indole (9c). Orangish yellow crustals; IR (KBr, cm^{-1}): ν 3061, 2974, 2929, 1637, 1584, 1491, 760. ^{1}H NMR ($CDCl_3$): δ (ppm) 1.83 (s, 6H), 7.44-7.47 (m, 2H), 7.55-7.64 (m, 4H), 7.79 (t, *J* = 7.8 Hz, 1H) 7.96 (t, *J* = 8.7 Hz, 2H), 8.71 (s, 1H, pyrazole), 9.58 (d, *J* = 8.1, 1H), 10.57 (s, 1H, pyrazole); ^{13}C NMR ($CDCl_3$): δ (ppm) 25.7, 53.56, 117.2, 118.2, 123.2, 124.6, 127.3, 127.7, 128.0, 128.2, 128.6, 129.2, 129.3, 129.6, 130.9, 131.0, 133.9, 136.6, 139.1, 139.9, 142.1, 178.9; Anal. Calcd. for $C_{23}H_{18}ClN_3$: C, 74.29%; H, 4.88%; N, 11.30%. Found: C, 73.78%; H, 4.65%; N, 11.16%.

2-(1-(3-Chlorophenyl)-1*H*-pyrazol-4-yl)-3,3-dimethyl -3*H*-benzo[*g*]indole (9d). Yellow crystals; IR (KBr, cm^{-1}): ν 3062, 2966, 2927, 1652, 1565, 1485, 773; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.86 (s, 6H), 7.45 (d, *J* = 4.2 Hz, 1H), 7.52 (d, *J* = 8.1, 1H), 7.57 (d, *J* = 8.7, 1H), 7.65 (d, *J* = 8.1 Hz, 1H), 7.83-7.91 (m, 2H), 7.96-8.06 (m, 3H), 9.59 (d, *J* = 8.4, 1H), 8.50 (s, 1H, pyrazole), 11.31 (s, 1H, pyrazole); ^{13}C NMR ($CDCl_3$): δ (ppm) 25.6, 53.4, 117.3, 117.8, 118.1, 120.4, 123.0, 124.5, 127.6, 128.2, 128.8, 128.9, 129.9, 130.3, 131.1, 133.9, 135.7, 137.0, 137.3, 141.9, 178.9; Anal. Calcd. for $C_{23}H_{18}ClN_3$: C, 74.29%; H, 4.88%; N, 11.30%. Found: C, 74.05%; H, 4.36%; N, 11.02%.

2-(1-(4-Chlorophenyl)-1*H*-pyrazol-4-yl)-3,3-dimethyl -3*H*-benzo[*g*]indole (9e). Brown crystals; IR (KBr, cm^{-1}): ν 3064, 2975, 1648, 1584, 1499, 1274, 947, 824; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.88 (s, 6H), 7.52-7.59 (m, 2H), 7.66 (ddd, J_1 = 8.4 Hz, J_2 = 5.4 Hz, J_3 = 1.2 Hz, 1H), 7.85 (ddd, J_1 = 8.4 Hz, J_2 = 5.4 Hz, J_3 = 1.2 Hz, 1H), 7.95-8.02 (m, 4H), 9.56 (d, *J* = 8.4 Hz, 1H), 8.47 (s, 1H, pyrazole), 11.29 (s, 1H, pyrazole); ^{13}C NMR ($CDCl_3$): δ (ppm) 25.6, 55.9, 112.0, 114.8, 118.1, 121.1, 123.3, 123.6, 124.5, 126.2, 127.6, 128.2, 128.9, 129.8, 130.1, 134.0, 135.5, 141.9, 179.0; Anal. Calcd. for $C_{23}H_{18}ClN_3$: C, 74.29%; H, 4.88%; N, 11.30%. Found: C, 73.81%; H, 4.42%; N, 11.14%.

3,3-Dimethyl-2-(1-(4-methoxyphenyl)-1*H*-pyrazol-4-yl)-3*H*-benzo[*g*]indole (9f). Light brown crystals; IR (KBr, cm^{-1}): ν 3074, 2973, 1603, 1585, 1519, 1251, 821, 634; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.86 (s, 6H), 3.89 (s, 3H), 7.06 (d, *J* = 4.5, 2H), 7.31 (d, *J* = 6.00 Hz, 2H), 7.69 (t, *J* = 7.2 Hz, 1H) ,7.69 (d, *J* = 9.00, 1H), 7.82 (d, *J* = 8.4, 2H), 8.86 (t, *J* = 6.9 Hz, 1H), 9.59 (d, *J* = 8.4 Hz, 1H), 8.46 (s, 1H, pyrazole), 11.13 (s, 1H, pyrazole); ^{13}C NMR ($CDCl_3$): δ (ppm) 25.9, 53.3, 55.7, 114.9, 115.0, 118.1, 121.4, 123.9, 124.6, 126.2, 126.5, 127.5, 128.2, 128.8, 129.5, 131.8, 134.9, 139.3, 141.8, 159.9, 179.00; Anal. Calcd. for $C_{24}H_{21}N_3O$: C, 78.45%; H, 5.76%; N, 11.44%. Found: C, 78.16%; H, 5.29%; N, 11.08%.

3,3-Dimethyl-2-(1-(4-nitrophenyl)-1*H*-pyrazol-4-yl)-3 *H*-benzo[*g*]indole (9g). Deep-red crystals; IR (KBr, cm^{-1}): ν 3079, 2968, 2929, 1596, 1501, 1336, 1272, 1109, 945, 851; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.65 (s, 6H), 7.54 (m, 2H, H-4 & H-7), 7.64 (t, *J* = 6.3 Hz, 1H, H-8), 7.83 (d, *J* = 8.4 Hz, 1H, H-5), 7.94 (d, *J* = 8.4 Hz, 1H, H-6), 8.06 (d, *J* = 8.4 Hz, 2H), 8.42 (s, 1H, pyrazole), 8.49 (s, 1H, pyrazole), 8.44 (d, *J* = 9.00, 1H), 8.76 (d, *J* = 8.4 Hz, 2H); ^{13}C NMR ($CDCl_3$): δ (ppm) 24.2, 54.3, 118.9, 119.1, 121.1, 123.3, 124.1, 125.5, 125.8, 126.3, 126.5, 127.1, 127.7, 128.1, 131.0, 134.0, 142.09, 143.9, 146.0, 178.5; Anal. Calcd. for $C_{23}H_{18}N_4O_2$: C, 72.24%; H, 4.74%; N, 14.65%. Found: C, 72.06%; H, 4.29%; N, 14.38%.

2-(1-(2,4-Dinitrophenyl)-1*H*-pyrazol-4-yl)-3,3-dimeth yl-3*H*-benzo[*g*]indole (9h). Brown crystals; IR (KBr, cm^{-1}): ν 3058, 2976, 2933, 1610, 1534, 1410, 1340, 948, 820, 740; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.60 (s, 6H), 7.53 (m, 2H, H-4 & H-7), 7.63 (t, *J* = 7.2, 1H, H-8),7.82 (d, *J* = 8.4 Hz, 1H, H-5), 7.93 (d, *J* = 8.4 Hz, 1H, H-6), 7.99 (d, *J* = 8.4 Hz, 1H), 8.50 (s, 1H, pyrazole), 8.51 (s, 1H, pyrazole), 8.60 (dd, J_1 = 8.4 Hz, J_2 = 2.4 Hz, 2H, H-9 & H-5), 8.7 (s, 1H); ^{13} C NMR ($CDCl_3$): δ (ppm) 24.1, 54.3, 118.9, 121.3, 122.5. 123.3, 124.2, 125.8, 126.1, 126.4, 127.6, 128.1, 128.8, 129.1, 130.2, 133.8, 136.8,

142.2, 143.2, 146.0, 179.2; Anal. Calcd. for $C_{23}H_{17}N_5O_4$: C, 64.63%; H, 4.01%; N, 16.39%. Found: C, 64.21%; H, 4.27%; N, 15.92%.

General procedure for synthesis of (12a-e). A mixture of malonaldehyde **8** (0.12 g, 0.45 mmol) and 3-(1,3-dioxolan-2-yl)-2-hydrazinylquinoline **10a-e** (0.45 mmol), in absolute ethanol (15 ml) was heated at reflux overnight. After removal of solvent, $HCl_{(aq.)}$ (2 M, 15 ml) was added to the residue and the solution was stirred for 1 h at r.t. Finally, the solution was neutralized by solid sodium carbonate. The precipitate was filtered off, washed with water and dried in *vacuo*. A pure sample for elemental analysis can be obtained by crystallization from ethanol.

2-(4-(3,3-Dimethyl-3*H*-benzo[*g*]indol-2-yl)-1*H*-pyrazol-1-yl)quinoline-3-carbaldehyde (12a). Yellow crystals; IR (KBr, cm^{-1}): ν 3040, 2924, 2854, 1684, 1619, 1585, 1434, 1404, 948, 755; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.65 (s, 6H), 7.53-7.63 (m, 4H), 7.79-8.13 (m, 5H), 8.60 (s, 1H), 8.83 (s, 1H, pyrazole), 8.73 (d, *J* = 8.1 Hz, 1H), 9.34 (s, 1H, pyrazole), 10.79 (s, 1H, CHO); ^{13}C NMR ($CDCl_3$): δ (ppm) 24.3, 54.4, 119.0, 123.5, 125.7, 126.0, 126.3, 126.5, 127.2, 127.5, 128.0, 128.3, 128.6, 129.1, 129.4, 129.8, 133.0, 133.8, 141.0, 142.7, 143.1, 144.2, 147.8, 177.7, 189.9; Anal. Calcd. for $C_{27}H_{20}N_4O$: C, 77.87%; H, 4.84%; N, 13.45%. Found: C, 77.67%; H, 4.47%; N, 13.92%.

2-(4-(3,3-Dimethyl-3*H*-benzo[*g*]indol-2-yl)-1*H*-pyrazol-1-yl)-7-methylquinoline-3-carbaldehyde (12b). Brown crystals; IR (KBr, cm^{-1}): ν 3047, 2970, 2920, 1681, 1624, 1591, 1494, 1442, 942, 812; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.61 (s, 6H), 2.64 (s, 3H), 7.46 (t, *J* = 9 Hz, 2H), 7.55 (d, *J* = 8.1 Hz, 1H), 7.64 (t, *J* = 9.00 Hz, 1H), 7.80 (d, *J* = 8.1 Hz, 1H), 7.89-7.94 (m, 3H), 8.62 (s, 1H), 8.73 (d, *J* = 8.1 Hz, 1H), 8.80 (s, 1H, pyrazole), 9.34 (s, 1H, pyrazole), 10.80 (s, 1H, CHO); ^{13}C NMR ($CDCl_3$): δ (ppm) 22.3, 24.3, 54.4, 118.875, 119.0, 122.6, 123.5, 124.6, 125.7, 125.9, 126.3, 127.2, 127.7, 128.0, 128.4, 129.0, 129.8, 133.8, 140.6, 142.7, 143.9, 144.2, 148.2, 148.5, 149.3, 177.7, 190.1; Anal. Calcd. for $C_{28}H_{22}N_4O$: C, 78.12%; H, 5.15%; N, 13.01%. Found: C, 77.87%; H, 5.47%; N, 12.72%.

2-(4-(3,3-Dimethyl-3*H*-benzo[*g*]indol-2-yl)-1*H*-pyrazol-1-yl)-8-methylquinoline-3-carbaldehyde (12c). Yellow crystals; IR (KBr, cm^{-1}): ν 3046, 2961, 2924, 1685, 1596, 1473, 1424, 1154, 947, 762; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.59 (s, 6H), 2.82 (s, 3H), 7.46-7.60 (m, 4H), 7.67-7.84 (m, 4H), 8.51 (s, 1H), 8.74 (s, 1H, pyrazole), 8.65 (d, *J* = 8.7 Hz, 1H), 9.31 (s, 1H, pyrazole), 10.76 (s, CHO); ^{13}C NMR ($CDCl_3$): δ (ppm) 17.8, 24.4, 54.4, 118.9, 123.0, 123.5, 124.3, 124.6, 125.8, 126.1, 126.3, 126.6, 127.0, 127.2, 127.3, 128.0, 128.4, 129.0, 129.3, 133.1, 133.9, 141.2, 142.8, 142.9, 146.8, 190.0, 190.2; Anal. Calcd. for $C_{28}H_{22}N_4O$: C, 78.12%; H, 5.15%; N, 13.01%. Found: C, 78.47%; H, 5.57%; N, 13.42%.

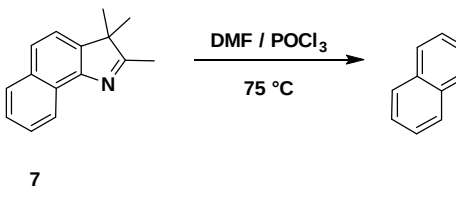
2-(4-(3,3-Dimethyl-3*H*-benzo[*g*]indol-2-yl)-1*H*-pyrazol-1-yl)-7-methoxyquinoline-3-carbaldehyde (12d). Light brown crystals; IR (KBr, cm^{-1}): ν 3050, 2966, 2928, 1676, 1619, 1593, 1491, 1405, 1237, 1140, 810; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.66 (s, 6H), 4.03 (s, 3H), 7.42-7.61 (m, 4H), 7.77-7.89 (m, 3H), 8.59 (s, 1H), 8.74 (d, *J* = 8.1 Hz, 2H), 8.76 (s, 1H, pyrazole), 9.30 (s, 1H, pyrazole), 10.77 (s, 1H, CHO); ^{13}C NMR ($CDCl_3$): δ (ppm) 24.3, 54.3, 55.8, 55.8, 106.7, 118.7, 119.0, 121.1, 121.8, 123.5, 125.7, 125.9, 126.3, 127.2, 127.5, 128.0, 128.5, 130.5, 133.8, 140.3, 142.6, 143.0, 149.1, 150.3, 163.8, 177.7, 190.1; Anal. Calcd. for $C_{28}H_{22}N_4O_2$: C, 75.32%; H, 4.97%; N, 12.55%. Found: C, 74.87%; H, 4.57%; N, 12.32%.

2-(4-(3,3-Dimethyl-3*H*-benzo[*g*]indol-2-yl)-1*H*-pyrazol-1-yl)-6-methoxyquinoline-3-carbaldehyde (12e). Brown crystals; IR (KBr, cm^{-1}): ν 3133, 2964, 2926, 1681, 1620, 1585, 1402, 1224, 948, 817; ^{1}H NMR ($CDCl_3$): δ (ppm) 1.67 (s, 6H), 3.98 (s, 3H), 7.54 (d, *J* = 8.1 Hz, 1H), 7.55-7.63 (m, 5H), 7.80 (d, *J* = 8.1 Hz, 1H), 7.92 (d, *J* = 8.1 Hz, 1H), 8.04 (d, *J* = 9 Hz, 1H), 8.60 (s, 1H), 8.72 (s, 1H, pyrazole), 9.29 (s, 1H, pyrazole), 10.77 (s, 1H, CHO); ^{13}C NMR ($CDCl_3$): δ (ppm) 24.4, 54.3, 55.8, 106.2, 118.6, 119.0, 123.4, 123.5, 125.7, 125.9, 126.1, 126.3, 127.2, 127.7, 128.0, 128.2, 129.9, 133.8, 139.2, 142.7, 142.8, 143.9, 146.7, 149.3, 158.5, 177.80, 190.2; Anal. Calcd. for $C_{28}H_{22}N_4O_2$: C, 75.32%; H, 4.97%; N, 12.55%. Found: C, 75.66%; H, 5.27%; N, 12.82%.

RESULTS AND DISCUSSION

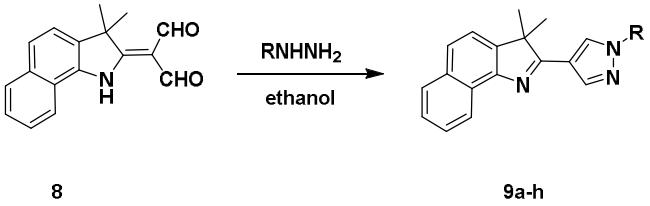
2,3,3-Trimethyl-3*H*-benzo[*g*]indole **7** was synthesized using the Fischer indole synthesis method via the reaction of 1-naphthylhydrazine and isopropyl methyl ketone in hot acetic acid. Exposure of 3*H*-indole **7** to the Vilsmeier reagent produced aminomethylene-malondialdehyde **8** (Scheme 2).

The structure of the aminomethylene malondialdehyde **8** is supported by the observation of the absence of a singlet at



7 8

Scheme 2



8 9a-h

Scheme 3

Table 1. Melting Points and the Yield of Products **9a-h**

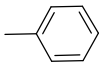
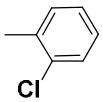
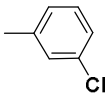
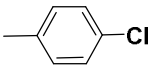
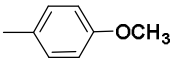
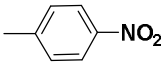
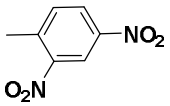
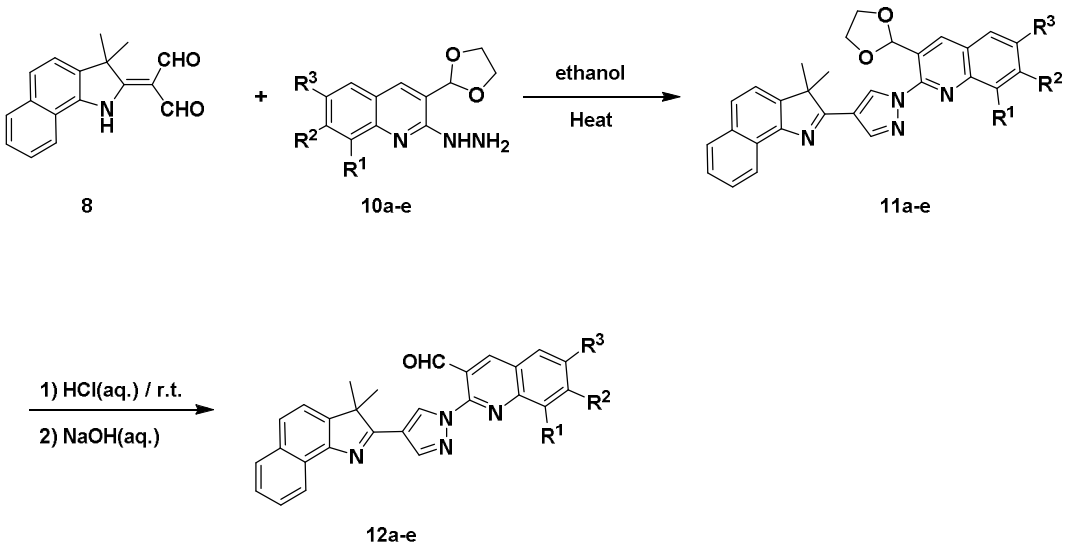
Entry	Compound	R	m.p. (°C)	Yield (%)
1	**9a**	H	102 -104	90
2	**9b**		218-220	75
3	**9c**		128-130	87
4	**9d**		218-220	85
5	**9e**		248-250	90
6	**9f**		249-251	75
7	**9g**		247-249	72
8	**9h**		285-287	77

Table 2. Melting Points and the Yield of Products **12a-e**

Entry	Compound	R^1	R^2	R^3	m.p. (°C)	Yield (%)
1	**12a**	H	H	H	243-245	80
2	**12b**	H	Me	H	233-235	70
3	**12c**	Me	H	H	216-218	70
4	**12d**	H	OMe	H	195-197	73
5	**12e**	H	H	OMe	231-233	70



Scheme 4

δ 2.49 for the 2-CH_3 group in compound **7** and, instead, the presence of two one-hydrogen singlets at δ 9.80 and δ 9.85 corresponding to aldehyde protons. Absorption at 3113 cm^{-1} was evidence for the presence of an N-H bond, further confirmed by ^{1}H NMR one-hydrogen signal for the N-hydrogen appearing at δ 14.30.

The malondialdehyde **8** on treatment with hydrazine and various arylhydrazines in ethanolic solution gave pyrazole derivatives in quantitative yields (Scheme 3). The structure of products was evident from their spectroscopic data. ^{1}H NMR spectra showed no peaks due to aldehydic protons and instead two singlets corresponding to the pyrazole ring protons. All physical data and the yields of products are given in Table 1.

We also found that reaction of malondialdehyde **8** with the 2-quinolylhydrazines **10a-e** [19] and finally hydrolysis of the acetal group afforded the *N*-quinolin-2-yl-pyrazole derivatives **12a-e** (Scheme 4). All physical data and the yield of products are given in Table **2**.

CONCLUSIONS

The reaction of Vilsmeier-Haack reagent with 2,3,3-trimethyl-3*H*-benzo[*g*]indole **7** led to double formylation of the C-2–methyl group and thus the compound was converted into malondialdehyde **8**. Compound **8** as a starting material was used for forming a wide variety of pyrazole derivatives **9** and **12** through condensation with arylhydrazines and 2-quinolylhydrazines

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