An Efficient Three-Component Synthesis of 3-(5-Alkyl/aryl-1,3,4-oxadiazol-2-yl)-3-hydroxy-1,3-dihydro-2*H*-indol-2-ones

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Abstract: An efficient three-component synthesis of 3-(1,3,4-oxadiazol-2-yl)-3-hydroxy-1,3-dihydro-2*H*-indol-2-ones is described. A mixture of *N*-isocyaniminotriphenylphosphorane, an isatin, and a carboxylic acid undergoes a 1:1:1 addition reaction under mild conditions to afford the title compounds in excellent yields.

Key words: *N*-isocyaniminotriphenylphosphorane, isatins, carboxylic acids, 1,3,4-oxadiazoles, multi-component reactions, heterocycles, cyclizations

Multi-component reactions (MCRs) have emerged as an efficient and powerful tool in modern synthetic organic chemistry due to their valued features such as atom economy, straightforward reaction design, and the opportunity to construct target compounds by the introduction of several diversity elements in a single chemical event. Typically, purification of products resulting from MCRs is also simple since all the organic reagents employed are consumed and are incorporated into the target compound.[1] MCRs, leading to interesting heterocyclic scaffolds, are particularly useful for the construction of diverse chemical libraries of 'drug-like' molecules. The isocyanide-based MCRs are especially important in this area.[1d,e]

During recent years there has been considerable investigation on different classes of oxadiazoles. In particular, compounds containing 1,3,4-oxadiazole nucleus have been shown to possess a wide range of pharmacological and therapeutic activities. Some 1,3,4-oxadiazoles have exhibited analgesic, anti-inflammatory, anticonvulsant, tranquilizing, myorelaxant, antidepressant, vasodilatatory, diuretic, antiulcer, antiarythmic, antiserotoninic, spasmolytic, hypotensive, antibronchocontrictive, anticholinergic, and antiemetic activities. Furthermore, many 1,3,4-oxadiazole derivatives have been reported as active inhibitors of several enzymes.[2,3]

Differently substituted 1,3,4-oxadiazoles have potential applications as photosensitizers,[4] liquid crystals,[5] ionic liquid solvents[6] and organic light-emitting devices.[7] Some of them also have photomechanic,[8] photoluminescent, and electrochromic properties.[9,10]

A huge number of synthetic or semi-synthetic indoles with significant biological or pharmacological activities have been described.[11] Some indole derivatives have been shown to possess antibacterial,[12] antitumor,[13] antiviral[14] and anti-inflammatory[15] properties.

So far, the most common synthetic methods reported for the preparation of 1,3,4-oxadiazoles involve: (i) transformation of an existing heterocycle and (ii) cyclizations. Cyclizations may represent either a single bond formation: cyclodehydration of 1,2-diacylhydrazines, oxidative cyclization of acylhydrazones, cyclodesulfurization of thiosemicarbazides, or formation of two bonds: condensation and then cyclization of hydrazides with carboxylic acids, acyl chlorides, esters, amides, trialkyl orthoesters, carbon disulfide or other C–S containing components, cyanogen bromide, potassium isocyanate, trichloromethylarenes, and imidoyl chlorides, among other approaches.[2,3,16]

As far as we know there is only one report in the literature on the synthesis of 3-hydroxy-3-(1,3,4-oxadiazol-2-yl)-1,3-dihydro-2*H*-indol-2-ones. Very recently, Pervak et al. used trimethylsilyl-1,3,4-oxadiazole as a synthon for the synthesis of these compounds.[17] Heating a mixture of trimethylsilyl-1,3,4-oxadiazole and an isatin in KF/dibenzo-18-crown-6 system in boiling toluene or xylene led to the corresponding trimethylsilyl ether intermediate, which was converted into 3-hydroxy-3-(1,3,4-oxadiazol-2-yl)-1,3-dihydro-2*H*-indol-2-ones on treatment with RbF.

There are several reports on the use of *N*-isocyaniminotriphenylphosphorane (Ph_3PNNC, **1**) (Scheme 1) in the synthesis of metal complexes.[18,19] However, applications of **1** in organic synthesis are rare. Recently, synthesis of 1,3,4-oxadiazepines[20] and 2-aryl-1,3,4-oxadiazoles[21] were reported using *N*-isocyaniminotriphenylphosphorane (**1**) in MCRs.

As part of our current studies on the design of new routes for the preparation of biologically active heterocyclic compounds,[22] very recently, we have described the synthesis of 2-aryl-5-hydroxyalkyl-1,3,4-oxadiazoles,[23a] 3-(1-hydroxyalkyl)[1,2,4]triazolo[4,3-*c*]quinazolines,[23b] and 3-aryl-1-(arylmethylideneamino)pyrrolidine-2,5-diones[23c] by use of **1** in MCRs. Herein we wish to report a new synthesis of 3-hydroxy-3-(1,3,4-oxadiazol-2-yl)-1,3-dihydro-2*H*-indol-2-ones. Thus, a mixture of *N*-isocyaniminotriphenylphosphorane (**1**), an isatin **2**, and a carboxylic acid **3** undergoes a 1:1:1 addition reaction in CH_2Cl_2 at ambient temperature to produce the corresponding 3-(5-alkyl/aryl-1,3,4-oxadiazol-2-yl)-3-hydroxy-1,3-dihy-

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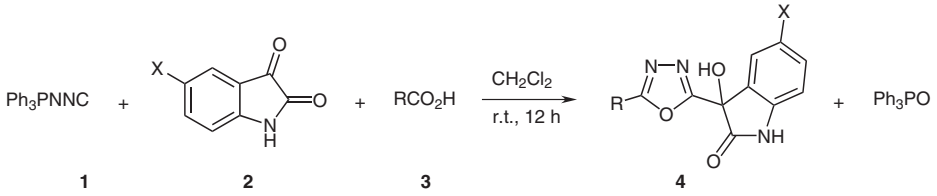
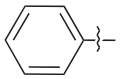
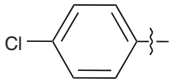
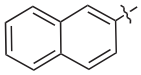
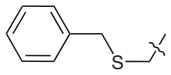
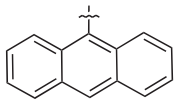
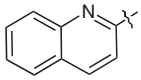
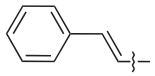
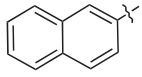


Scheme 1 One-pot three-component synthesis of 3-(5-alkyl/aryyl-1,3,4-oxadiazol-2-yl)-3-hydroxy-1,3-dihydro-2*H*-indol-2-ones **4**

dro-2*H*-indol-2-ones **4a**–**h** in 92–98% yields (Scheme 1, Table 1).

All the reactions went to completion within 12 hours. ^{1}H NMR analysis of the reaction mixtures clearly indicated formation of the corresponding 3-(1,3,4-oxadiazol-2-yl)-3-hydroxy-1,3-dihydro-2*H*-indol-2-ones **4**. Any product other than **4** and triphenylphosphine oxide could not be detected by NMR spectroscopy.

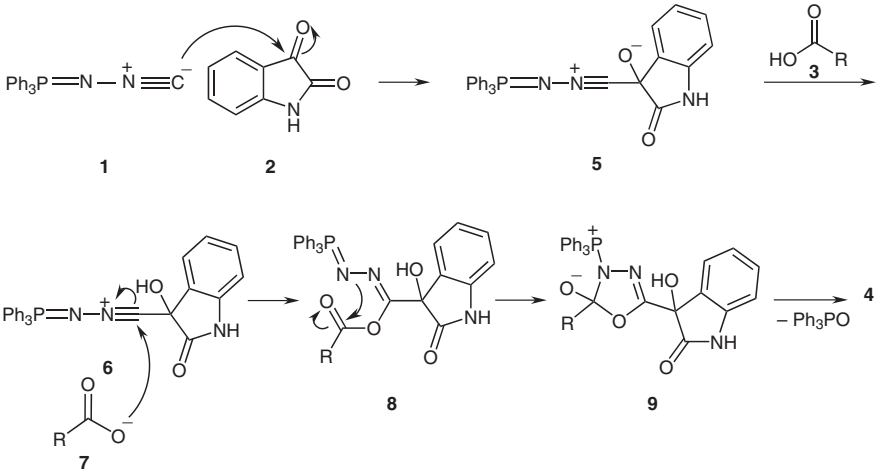
Table 1 1,3,4-Oxadiazoles **4a**–**h**

4	R	X	Yield (%)[a]
a		H	96
b		H	96
c		H	98
d		H	95
e		NO_2	94
f		NO_2	97
g		NO_2	92
h		NO_2	93

[a] Isolated yields.

The structures of the isolated products **4** were confirmed on the basis of IR, ^{1}H and ^{13}C NMR spectroscopy, mass spectrometry, and elemental analysis. The IR spectrum of **4a** showed absorptions at 3312, 3214 and 1711 cm^{-1} indicating the presence of amide NH, hydroxy, and carbonyl functionalities. The mass spectrum of **4a** displayed the molecular ion (M^+) peak at m/z = 293, which was consistent with the 1:1:1 adduct of *N*-isocyaniminotriphenylphosphorane, benzoic acid, and isatin with the loss of triphenylphosphine oxide. The ^{1}H NMR spectrum of **4a** exhibited two fairly sharp signals due to OH (δ = 7.65) and NH (δ = 10.80) groups, as well as characteristic signals for the nine H atoms of the phenyl and phenylene moieties in the aromatic region of the spectrum. The ^{1}H-decoupled ^{13}C NMR spectrum of **4a** showed a distinct resonance at δ = 72.56 due to COH group along with three deshielded characteristic resonances at δ = 164.63 and 164.70 for the two oxadiazole carbon atoms, and δ = 173.64 due to the carbonyl group as well as other ten signals for the aromatic carbon atoms (7 CH and 3 C) in agreement with the proposed structure.

A mechanistic rationalization for this reaction is provided in Scheme 2. On the basis of the well-established chemistry of isocyanides,[1d,e,24–26] it is reasonable to assume that the first step could involve nucleophilic addition of the isocyanide **1** on the isatin **2** and subsequent protonation of the alkoxide intermediate **5** by the acid **3**, leading to the nitrilium intermediate **6**. This intermediate may be attacked



Scheme 2 Proposed mechanism for the reaction

by the conjugate base of the acid **7** to form the adduct **8**. This adduct may undergo intramolecular aza-Wittig reaction of the iminophosphorane moiety with the ester carbonyl to afford the isolated 3-(1,3,4-oxadiazol-2-yl)-3-hydroxy-1,3-dihydro-2*H*-indol-2-ones **4** by removal of triphenylphosphine oxide from the betaine intermediate **9**.

In summary, we have developed a one-pot three-component reaction between *N*-isocyaniminotriphenylphosphorane (**1**), isatins **2** and carboxylic acids **3** for the preparation of 3-(5-alkyl/aryl-1,3,4-oxadiazol-2-yl)-3-hydroxy-1,3-dihydro-2*H*-indol-2-ones **4**, which are of potential synthetic and pharmacological interest. Mild reaction conditions and excellent yields of the products are the main advantages of this method. The reactions were performed under neutral conditions, and the starting materials and reagents have been mixed without any activation or modification. The simplicity of this method makes it an interesting alternative to other 1,3,4-oxadiazole syntheses. 3-(1,3,4-Oxadiazol-2-yl)-3-hydroxy-2*H*-indol-2-ones prepared in the present study may find useful applications in synthetic organic, bioorganic, and medicinal chemistry.

All the chemicals were obtained from Merck (Germany), and were used without further purification. Melting points were measured on an Electrothermal 9100 apparatus and are uncorrected. Elemental analyses for C, H, and N were performed using a Heraeus CHN-O-Rapid analyzer. Mass spectra were recorded on an Agilent Technologies (HP) 5973 mass spectrometer operating at an ionization potential of 20 eV. ^{1}H and ^{13}C NMR spectra were measured (DMSO-d_6 solution) with a Bruker DRX-500 Avance spectrometer at 500.1 and 125.8 MHz, respectively. IR spectra were recorded on a Shimadzu IR–460 spectrometer. Chromatography columns were prepared from Merck silica gel 60.

1,3,4-Oxadiazoles 4a–h; General Procedure

A mixture of *N*-isocyaniminotriphenylphosphorane (**1**; 302 mg, 1 mmol), an appropriate isatin **2** (1 mmol), and an appropriate carboxylic acid **3** (1 mmol) in CH_2Cl_2 (4 mL) was stirred at r.t. for 12 h. Then, the solvent was removed and the residue was purified by column chromatography using *n*-hexane–EtOAc (4:1) as eluent. The solvent was removed to afford the product (Table 1).

3-Hydroxy-3-(5-phenyl-1,3,4-oxadiazol-2-yl)-1,3-dihydro-2*H*-indol-2-one (4a)

Yield: 0.28 g (96%); light pink crystals; mp 234 °C.

IR (KBr): 3312 (NH), 3214 (OH), 1711 (C=O), 1611, 1550, 1462, 1368, 1229, 1238, 1183, 1118, 1074, 1020, 925, 759 cm^{-1}.

^{1}H NMR (500.1 MHz, DMSO-d_6): δ = 6.92 (d, *J* = 7.7 Hz, 1 H, CH), 7.04 (t, *J* = 7.5 Hz, 1 H, CH), 7.33 (t, *J* = 7.7 Hz, 1 H, CH), 7.46 (d, *J* = 7.4 Hz, 1 H, CH), 7.58–7.64 (m, 3 H, 3 × CH), 7.65 (s, 1 H, OH), 10.80 (s, 1 H, NH).

^{13}C NMR (125.8 MHz, DMSO-d_6): δ = 72.56 (COH), 110.39 (CH), 122.37 (CH), 122.90 (C), 125.40 and 126.61 (2 × CH), 128.38 (C), 129.47, 130.66 and 132.24 (3 × CH), 141.93 (C), 164.63 and 164.70 (2 × OC=N), 173.64 (C=O).

EI-MS: *m*/*z* (%) = 293 (15, [M$^+$]), 279 (13), 266 (9), 229 (9), 191 (10), 167 (22), 149 (86), 112 (15), 97 (18), 83 (27), 77 (15), 69 (66), 57 (69), 43 (100).

Anal. Calcd for $C_{16}H_{11}N_3O_3$ (293.28): C, 65.53; H, 3.78; N, 14.33. Found: C, 65.7; H, 3.8; N, 14.1.

3-[5-(4-Chlorophenyl)-1,3,4-oxadiazol-2-yl]-3-hydroxy-1,3-dihydro-2*H*-indol-2-one (4b)

Yield: 0.31 g (96%); light pink crystals; mp 236 °C.

IR (KBr): 3320 (OH), 3189 (NH), 1703 (C=O), 1606, 1545, 1470, 1403, 1347, 1280, 1239, 1185, 1127, 1078, 1009, 952, 929, 877, 829, 738 cm^{-1}.

^{1}H NMR (500.1 MHz, DMSO-d_6): δ = 6.92 (d, *J* = 7.7 Hz, 1 H, CH), 7.04 (t, *J* = 7.5 Hz, 1 H, CH), 7.33 (t, *J* = 7.8 Hz, 1 H, CH), 7.46 (d, *J* = 7.4 Hz, 1 H, CH), 7.65 (s, 1 H, OH), 7.68 (d, *J* = 8.6 Hz, 2 H, 2 × CH), 8.00 (d, *J* = 8.6 Hz, 2 H, 2 × CH), 10.80 (s, 1 H, NH).

^{13}C NMR (125.8 MHz, DMSO-d_6): δ = 72.56 (COH), 110.42 (CH), 121.80 (C), 122.40 and 125.46 (2 × CH), 128.32 (C), 128.47 and 129.69 (2 × CH), 130.71 (CH), 137.04 and 141.95 (2 × C), 163.99 and 164.81 (2 × OC=N), 173.58 (C=O).

EI-MS: *m*/*z* (%) = 329 (2, [M$^+$ ^{37}Cl]), 327 (8, [M$^+$ ^{35}Cl]), 293 (24), 279 (20), 236 (16), 191 (11), 167 (31), 149 (100), 97 (28), 83 (31), 77 (11), 69 (36), 57(96), 43 (40).

Anal. Calcd for $C_{16}H_{10}ClN_3O_3$ (327.72): C, 58.64; H, 3.08; N, 12.82. Found: C, 58.5; H, 3.2; N, 12.7.

3-Hydroxy-3-[5-(2-naphthyl)-1,3,4-oxadiazol-2-yl]-1,3-dihydro-2*H*-indol-2-one (4c)

Yield: 0.33 g (98%); light pink crystals; mp 273–274 °C.

IR (KBr): 3158 (NH), 3118 (OH), 1725 (C=O), 1616, 1537, 1467, 1381, 1329, 1234, 1184, 1115, 1073, 1031, 994, 917, 865, 810, 747, 661 cm^{-1}.

^{1}H NMR (500.1 MHz, DMSO-d_6): δ = 6.97 (d, *J* = 7.8 Hz, 1 H, CH), 7.07 (t, *J* = 7.5 Hz, 1 H, CH), 7.35 (t, *J* = 7.7 Hz, 1 H, CH), 7.55 (d, *J* = 7.4 Hz, 1 H, CH), 7.58–7.65 (m, 2 H, 2 × CH), 7.75 (s, 1 H, OH), 7.98 (d, *J* = 7.6 Hz, 1 H, CH), 8.05 (d, *J* = 8.5 Hz, 1 H, CH), 8.09 (d, *J* = 8.5 Hz, 1 H, CH), 8.14 (d, *J* = 7.5 Hz, 1 H, CH), 8.61 (s, 1 H, CH), 10.88 (s, 1 H, NH).

^{13}C NMR (125.8 MHz, DMSO-d_6): δ = 72.70 (COH), 110.51 (CH), 120.24 (C), 122.49, 122.77, 125.56, 127.13, 127.35, 127.87 and 128.33 (7 × CH), 128.49 (C), 128.95, 129.33 and 130.76 (3 × CH) 132.41, 134.30 and 142.05 (3 × C), 164.81 and 165.00 (2 × OC=N), 173.79 (C=O).

EI-MS: *m*/*z* (%) = 343 (100, [M$^+$]), 314 (7), 287 (14), 230 (5), 195 (10), 153 (94), 146 (20), 127 (35), 119 (39), 92 (18), 77 (9), 65 (9).

Anal. Calcd for $C_{20}H_{13}N_3O_3$ (343.34): C, 69.96; H, 3.82; N,12.24. Found: C, 69.9; H, 3.8; N, 12.3.

3-{5-[(Benzylsulfanyl)methyl]-1,3,4-oxadiazol-2-yl}-3-hydroxy-1,3-dihydro-2*H*-indol-2-one (4d)

Yield: 0.33 g (95%); light pink crystals; mp 178 °C.

IR (KBr): 3310 (NH), 3287 (OH), 1709 (C=O), 1615, 1572, 1463, 1409, 1352, 1186, 1125, 1082, 1033, 992, 924, 754, 700 cm^{-1}.

^{1}H NMR (500.1 MHz, DMSO-d_6): δ = 3.77 and 3.88 (2 s, 4 H, 2 × CH_2), 6.93 (d, *J* = 7.7 Hz, 1 H, CH), 7.04 (t, *J* = 7.6 Hz, 1 H, CH), 7.24 (t, *J* = 7.0 Hz, 1 H, CH), 7.26–7.33 (m, 5 H, 5 × CH), 7.36 (d, *J* = 7.4 Hz, 1 H, CH), 7.60 (s, 1 H, OH), 10.80 (s, 1 H, NH).

^{13}C NMR (125.8 MHz, DMSO-d_6): δ = 23.47 and 35.12 (2 × CH_2), 72.62 (COH), 110.45, 122.39, 125.26 and 127.17 (4 × CH), 128.45 (C), 128.49, 128.97 and 130.71 (3 × CH), 137.09 and 141.94 (2 × C), 164.89 and 165.30 (2 × OC=N), 173.67 (C=O).

EI-MS: *m*/*z* (%) = 353 (<1, [M$^+$]), 291 (12), 263 (9), 231 (92), 213 (10), 206 (7), 181 (8), 161 (11), 147 (24), 119 (43), 123 (44), 91 (100), 84 (56), 77 (13), 65 (24).

Anal. Calcd for $C_{18}H_{15}N_3O_3S$ (353.40): C, 61.18; H, 4.28; N, 11.89. Found: C, 61.2; H, 4.3; N, 11.9.

3-[5-(9-Anthryl)-1,3,4-oxadiazol-2-yl]-3-hydroxy-5-nitro-1,3-dihydro-2*H*-indol-2-one (4e)

Yield: 0.41 g (94%); pale brown powder; mp 272–273 °C.

IR (KBr): 3152 (NH), 3097 (OH), 1755 (C=O), 1617, 1531, 1461, 1404, 1331, 1244, 1186, 1106, 1012, 935, 899, 837, 782, 737, 687 cm^{-1}.

^1H NMR (500.1 MHz, DMSO-d_6): δ = 7.20 (d, *J* = 8.7 Hz, 1 H, CH), 7.60–7.66 (m, 4 H, 4 × CH), 7.89–7.94 (m, 2 H, 2 × CH), 8.14 (br s, 1 H, OH), 8.21–8.28 (m, 2 H, 2 × CH), 8.35 (d, *J* = 8.7 Hz, 1 H, CH), 8.46 (s, 1 H, CH), 8.98 (s, 1 H, CH), 11.61 (br s, 1 H, NH).

^{13}C NMR (125.8 MHz, DMSO-d_6): δ = 72.09 (COH), 111.03 (CH), 115.89 (C), 121.53, 124.39, 126.02, 127.87, 128.33 and 128.97 (6 × CH), 129.09, 130.48 and 130.57 (3 × C), 132.07 (CH), 142.73 and 148.49 (2 × C), 163.42 and 164.73 (2 × OC=N), 173.75 (C=O).

EI-MS: *m*/*z* (%) = 438 (6, [M^+]), 262 (8), 246 (78), 219 (21), 205 (100), 190 (39), 177 (53), 164 (44), 151 (17), 88 (23), 75 (17), 63 (27).

Anal. Calcd for $C_{24}H_{14}N_4O_5$ (438.40): C, 65.75; H, 3.22; N, 12.78. Found: C, 65.8; H, 3.3; N, 12.7.

3-Hydroxy-5-nitro-3-[5-(2-quinolyl)-1,3,4-oxadiazol-2-yl]-1,3-dihydro-2*H*-indol-2-one (4f)

Yield: 0.38 g (97%); pale brown powder; mp 291 °C.

IR (KBr): 3124 (NH), 3100 (OH), 1741 (C=O), 1617, 1533, 1473, 1392, 1334, 1297, 1261, 1180, 1124, 1097, 1038, 1008, 943, 903, 842, 775, 743, 669 cm^{-1}.

^1H NMR (500.1 MHz, DMSO-d_6): δ = 7.18 (d, *J* = 8.5 Hz, 1 H, CH), 7.72 (dd, *J* = 7.3, 7.2 Hz, 1 H, CH), 7.87 (dd, *J* = 7.5, 7.3 Hz, 1 H, CH), 8.08 (d, *J* = 8.1 Hz, 1 H, CH), 8.16 (s, 1 H, OH), 8.20 (d, *J* = 8.3 Hz, 1 H, CH), 8.27 (d, *J* = 8.4 Hz, 1 H, CH), 8.32 (d, *J* = 9.3 Hz, 1 H, CH), 8.34 (s, 1 H, CH), 8.61 (d, *J* = 8.4 Hz, 1 H, CH), 11.62 (s, 1 H, NH).

^{13}C NMR (125.8 MHz, DMSO-d_6): δ = 72.34 (COH), 111.00, 119.72, 121.51, 127.85, 125.56 and 128.23 (5 × CH), 128.45 (C), 128.58 (CH), 129.18 (C), 129.35, 130.99 and 138.17 (3 × CH), 142.56, 142.70, 147.16 and 148.37 (4 × C), 164.80 and 164.81 (2 × OC = N), 173.66 (C = O).

EI-MS: *m*/*z* (%) = 389 (24, [M^+]), 333 (10), 277 (21), 197 (60), 192 (15), 164 (43), 155 (41), 140 (15), 128 (100), 114 (9), 101 (20), 90 (22), 75 (19), 63 (24).

Anal. Calcd for $C_{19}H_{11}N_5O_5$ (389.33): C, 58.62; H, 2.85; N, 17.99. Found: C, 58.5; H, 2.9; N, 17.8.

3-Hydroxy-5-nitro-3-{5-[(*E*)-2-phenyl-1-ethenyl]-1,3,4-oxadiazol-2-yl}-1,3-dihydro-2*H*-indol-2-one (4g)

Yield: 0.33 g (92%); pale brown powder; mp 264–265 °C.

IR (KBr): 3186 (NH), 3106 (OH), 1758 (C=O), 1617, 1524, 1472, 1337, 1299, 1247, 1181, 1104, 1020, 961, 909, 834, 760, 719, 679 cm^{-1}.

^1H NMR (500.1 MHz, DMSO-d_6): δ = 7.15 (d, *J* = 8.9 Hz, 1 H, CH), 7.37 (d, *J* = 16.6 Hz, 1 H, CH), 7.41–7.45 (m, 3 H, 3 × CH), 7.65 (d, *J* = 16.6 Hz, 1 H, CH), 7.80 (d, *J* = 8.2 Hz, 2 H, 2 × CH), 7.96 (br s, 1 H, OH), 8.29 (d, *J* = 2.2 Hz, 1 H, CH), 8.29 (dd, *J* = 8.9, 2.2 Hz, 1 H, CH), 11.53 (s, 1 H, NH).

^{13}C NMR (125.8 MHz, DMSO-d_6): δ = 72.08 (COH), 109.67, 110.89, 121.28, 127.72, 127.96 and 128.90 (6 × CH), 129.20 (C), 130.11 (CH), 134.43 (C), 139.62 (CH), 142.67 and 148.28 (2 × C), 162.90 and 165.12 (2 × OC=N), 173.71 (C=O).

EI-MS: *m*/*z* (%) = 364 (21, [M^+]), 289 (34), 277 (16), 262 (12), 254 (16), 172 (65), 164 (43), 159 (9), 131 (100), 117 (14), 104 (67), 91 (89), 77 (45), 57 (39).

Anal. Calcd for $C_{18}H_{12}N_4O_5$ (364.32): C, 59.34; H, 3.32; N, 15.38. Found: C, 59.5; H, 3.4; N, 15.2.

3-Hydroxy-3-[5-(2-naphthyl)-1,3,4-oxadiazol-2-yl]-5-nitro-1,3-dihydro-2*H*-indol-2-one (4h)

Yield: 0.36 g (93%); pale brown powder; mp 269–270 °C.

IR (KBr): 3158 (NH), 3091 (OH), 1734 (C=O), 1615, 1526, 1455, 1404, 1341, 1290, 1232, 1190, 1123, 1068, 972, 940, 888, 829, 782, 740, 702 cm^{-1}.

^1H NMR (500.1 MHz, DMSO-d_6): δ = 7.17 (d, *J* = 8.5 Hz, 1 H, CH), 7.60–7.70 (m, 2 H, 2 × CH), 8.01 (d, *J* = 7.4 Hz, 1 H, CH), 8.07 (d, *J* = 7.5 Hz, 1 H, CH), 8.08 (s, 1 H, OH), 8.12 (d, *J* = 8.4 Hz, 1 H, CH), 8.18 (d, *J* = 7.4 Hz, 1 H, CH), 8.31 (d, *J* = 8.5 Hz, 1 H, CH), 8.36 (s, 1 H, CH), 8.64 (s, 1 H, CH), 11.58 (s, 1 H, NH).

^{13}C NMR (125.8 MHz, DMSO-d_6): δ = 72.18 (COH), 110.96 (CH), 120.22 and 121.48 (2 × C), 122.83, 127.27, 127.40, 127.82, 127.90, 128.41, 129.01, 129.19 and 129.37 (9 × CH), 134.35, 132.42, 142.70 and 148.34 (4 × C), 163.74 and 165.38 (2 × OC=N), 173.80 (C=O).

EI-MS: *m*/*z* (%) = 388 (36, [M^+]), 277 (40), 231 (40), 196 (80), 164 (54), 155 (100), 139 (24), 127 (77), 104 (20), 91 (79), 77 (27), 63 (34).

Anal. Calcd for $C_{20}H_{12}N_4O_5$ (388.34): C, 61.86; H, 3.11; N, 14.43. Found: C, 61.9; H, 3.2; N, 14.4.

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