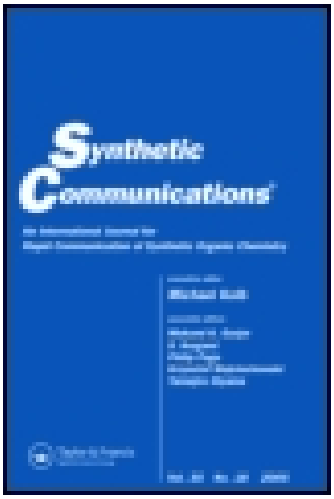

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SYNTHESIS OF BENZ[*d*]OXAZOLONES INVOLVING CONCOMITANT ACETYL MIGRATION FROM OXYGEN TO NITROGEN

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Heating of* o*-acetoxybenzoyl azides* 6–10 *in toluene leads to the Curtius reaction, which, when followed by closure of oxazolone ring with concomitant migration of acetyl group from oxygen to nitrogen, produces 3-acetoxybenz[*d*]oxazol-2(3*H*)-ones* 11–15, *which undergo hydrolysis with hot dilute hydrochloric acid to furnish benz[*d*]oxazol-2(3*H*)-ones* 17–21. *Thermal reaction of 2-hydroxy-5-nitrobenzoyl azide (*22*) in toluene finally yields a mixture of 5-nitrobenz[*d*]oxazol-2(3*H*)-one (*20*) and 5-nitrobenz[*d*]isoxazol-3(2*H*)-one (*23*).

Keywords: Benz[*d*]oxazolone; concomitant migration; 5-nitrobenz[*d*]isoxazolone; *o*-acetoxybenzoyl azides; O to N acetyl migration

INTRODUCTION

Benzoxazoles, especially the benz[*d*]oxazolone compounds, are of interest as established or potential anticonvulsants,[1,2] cardiotonics,[3] central nervous system agents[4], β-3-adrenergic receptor antagonists,[5] antivirals,[6,7] analgesic and anti-inflamatory agents,[8,9] antimicrobials,[9–13] fungicides,[13] and herbicides and plant-growth regulators.[14] The literature is ambiguous in reporting the syntheses of benz[*d*]oxazol-2(3*H*)-ones and benz[*d*]isoxazol-3(2*H*)-ones. In one report, *o*-hydroxyphenylhydroxamic acid reacted with thionyl chloride and pyridine to yield benz[*d*]isoxazol-3-one, theorectically through the intermediate formation of a chloramine compound,[15] and in a different report, 4-(2-hydroxyphenyl)-2,5-dioxa-3-thiazoline-5-oxide, prepared from *o*-hydroxyphenylhydroxamic acid and thionyl chloride, furnished benz[*d*]isoxazol-3-one when treated with triethylamine.[16] Kinstle and Darlog reported in 1977[16b] that they produced a mixture of benzoxazolone and benzisoxazolone from *o*-hydroxyphenylhydroxamic acid under similar reaction conditions. In continuation of our ongoing studies[17] on benz[*d*]oxazolone compounds, we report the synthesis of 3-acetylbenz[*d*]oxazol-2(3*H*)-ones by thermal conversion of *o*-acetoxy-benzoyl azides, with concomitant migration of acetyl group from

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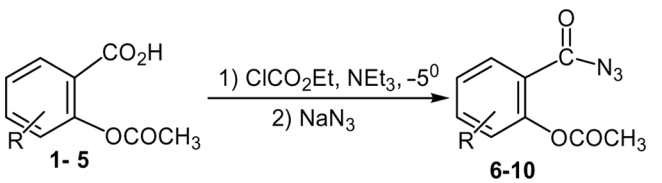
oxygen to nitrogen, and subsequent hydrolysis of them with hot aqueous hydrochloric acid to benz[*d*]oxazole-2(3*H*)-ones.

RESULTS AND DISCUSSION

There is a report[18] of conversion of the azide of salicylic acid to benz[*d*]isoxazol-3(2*H*)-one by heating in benzene. Since we observed that the exothermic reaction always occurs with explosive violence when carried out on a gram scale, we surmised that use of *o*-acetoxybenzoyl azides **6–10** as the starting materials when the acetoxy oxygen should have diminished nucleophilicity would form the initial intermediates, and these would be followed by smooth Curtius reaction and subsequent formation of the oxazole ring with concomitant migration of acetyl moiety from oxygen to nitrogen to produce 3-acetylbenz[*d*]oxazol-2(3*H*)-ones **11–15** in a one-pot reaction (Scheme 1). *o*-Acetoxybenzoyl azides were prepared from the corresponding *o*-acetoxybenzoic acid compounds in one-pot reactions following the procedure of Weinstock.[19]

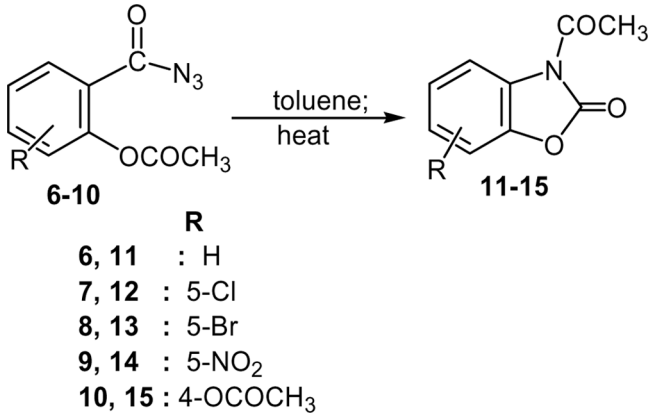
Reaction of 2-acetoxybenzoic acids **1–5** with ethyl chloroformate in aqueous acetone in the presence of triethyl amine at $-5\,^{\circ}C$ (bath temperature) followed by treatment with sodium azide produced 2-acetoxybenzoyl azide compounds **6–10** in very good yields (Scheme 1). The product, in each case, was extracted with ether, and careful removal of ether at $10\,^{\circ}C$ under reduced pressure furnished the title compound, which can be stored under refrigeration without decomposition for only a few days. Because of the inherent unstable nature of the acyl azides, crystallization and elemental analyses of **6–10** were not attempted. The compounds have been characterized by spectroscopic means. Thus, **8** shows infrared (IR, KBr) absorptions at 2140 (S, $-\overset{+}{N} \equiv N$), 1765 (s, Ar*C*=O str.), 1690 (s, CH_3-*C*=O) cm^{-1}; ^1H NMR ($CDCl_3$) signals at δ 9.11 (d, 1H, J_m 1.9 Hz, **H**-6), 7.70 (dd, 1H, J_o 8.6 Hz, J_m 2.0 Hz, **H**-4), 7.01 (d, 1H, J_o 8.6 Hz, **H**-3), 2.41 (s, 3H, CH_3); and ^{13}C NMR ($CDCl_3$) signals at δ 168.98 and 168.96 (both s, two **C**=O), 149.99 (s, **C**-2), 137.81 (d, **C**-4), 134.28 (d, **C**-6), 125.92 (d, **C**-3), 125.16 (s, **C**-5), 119.03 (s, **C**-1), 20.79 (q, CH_3).

2-Acetoxybenzoyl azides **6–10** were taken in dry toluene and placed in a water bath whose temperature was raised slowly. The reaction started when the



R
1, 6 : H
2, 7 : 5-Cl
3, 8 : 5-Br
4, 9 : 5-NO_2
5, 10 : 4-$OCOCH_3$

Scheme 1. Conversion of 2-acetoxybenzoic acids **1–5** to 2-acetoxybenzoyl azides **6–10**.



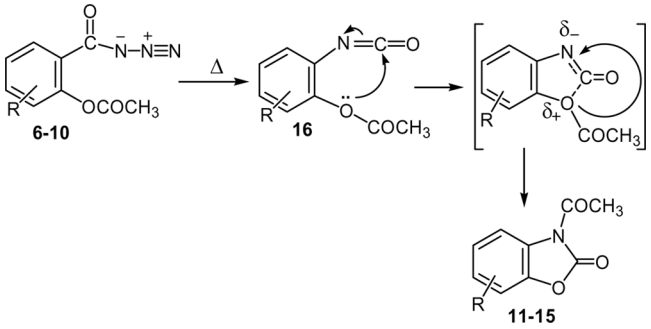
Scheme 2. Conversion of 2-acetoxybenzoyl azides **6–10** to 3-acetylbenz[*d*]oxazol-2(3*H*)-ones **11–15**.

temperature was ~50 °C; effervescence continued, and the temperature was raised very slowly until it reached 80 °C (Scheme 2). Removal of solvent from the reaction mixture followed by crystallization of the product from petrol (60–80 °C) furnished 3-acetylbenz[*d*]oxazol-2(3*H*)-ones **11–15** (Table 1). The compounds have been assigned structures **11–15** based on their IR, ^{1}H NMR, and ^{13}C NMR data. Thus, the IR spectrum of **11** shows two strong absorptions at 1840 and 1800 cm^{-1} assignable to symmetrical and unsymmetrical C=O stretching and a strong absorption at 1725 cm^{-1} assignable to CH_3C=O carbonyl stretching. A three-proton singlet in its ^{1}H NMR ($CDCl_3$) spectrum at δ 2.75 confirmed the presence of a $NCOCH_3$ moiety. In its ^{13}C NMR ($CDCl_3$) spectrum, **11** displayed two diagnostic methine carbon signals at relatively low δ values of 109.72 and 115.82 assignable to C-7 and C-4 respectively and only one quaternary carbon at a high δ value of 142.00 for C-7a; apart from two quaternary carbon signals at δ 169.36 and 151.38 corresponding to –*C*OCH_3 and C-2, the remaining quaternary carbon signal at δ 127.50 can be assigned to C-3a, supporting the attachment of C-3a to $NCOCH_3$ and the signal at δ 24.80 to methyl carbon.

A plausible route for thermal conversion of the 2-acetoxybenzoyl azides **6–10** to 3-acetylbenz[*d*]oxazoles is depicted in Scheme 3. Curtius reaction of the acyl azides **6–10** initially leads to the formation of 2-acetyloxyphenyl isocyanate compound **16**, which may at once undergo anchimeric assistance of the acetoxy-oxygen, whereby a nucleophilic character is developed on the nitrogen center and as a result the acetyl group migrates from oxygen to nitrogen.

Table 1. Thermal reaction of *o*-acetoxybenzoyl azide (**6–10**) in toluene (Scheme 1)

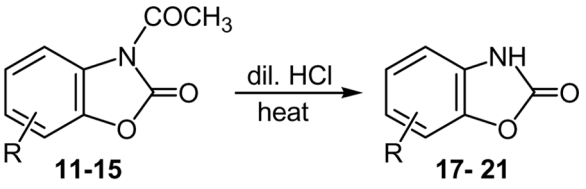
Substrate	R	Time (h)	Product	Mp (°C)	Yield (%)
6	H	6	**11**	85–86	91
7	5-Cl	5.25	**12**	140	88
8	5-Br	6	**13**	158	85
9	5-NO_2	6	**14**	166–8	85
10	6-Oac	6.5	**15**	194–196	82



Scheme 3. Plausible mechanism of change of 2-acetoxybenzoyl azides **6–10** to 3-acetylbenz[*d*]oxazol-2(3*H*)-ones **11–15**.

Hydrolysis of **11–15** by heating with 5% aqueous hydrochloric acid on a steam bath for 8 h afforded benz[*d*]oxazol-2(3*H*)-ones **17–21** (Scheme 4, Table 2). Assignment of the structures **17–21** for the products is established spectroscopically, for example, **17** was assigned by strong and broad absorption, centered at 3500 cm^{-1}, for the N-H stretching and a pair of sharp peaks at 1750 and 1790 cm^{-1} for the symmetrical and unsymmetrical stretching of C(2) = O respectively in its IR spectrum; support for this structure (**17**) also comes from the signals in the ^{13}C NMR ($CDCl_3$) spectrum obtainable at δ144.06 (s, C-7a), 129.43 (s, C-3a), 109.96 (d, C-7), and 110.17 (d, C-4). The two methine signals of relatively low δ_C values (109.96 and 110.17) rule out the alternative possibility of the product being benz[*d*]isoxazol-3(2*H*)-one.

Subsequently, we attempted to assess the effect of the NO_2 group at C-5 of salicylic acid on the course of reaction during heating 2-hydroxy-5-nitrobenzoyl azide (**22**) because the 5-nitro substituent would decrease the migratory aptitude of the 2-hydroxyphenyl ring, possibly suppressing the Curtius-type rearrangement; at the same time, the 5-NO_2 group diminishes the nucleophilicity of the 2-OH group as



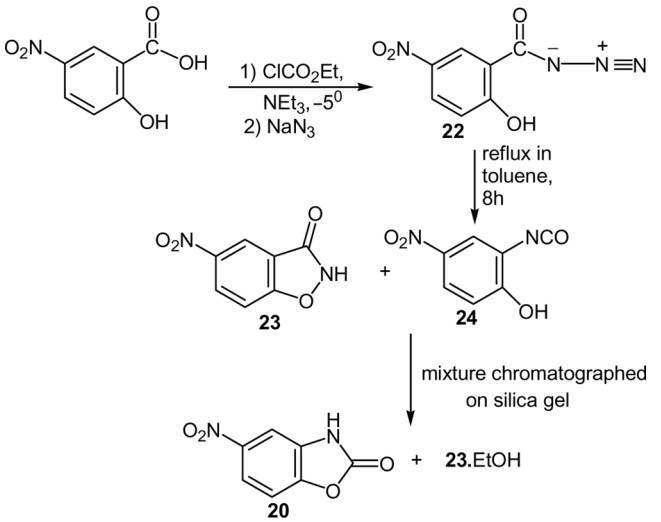
	R
11, 17	: H
12, 18	: 5-Cl
13, 19	: 5-Br
14, 20	: 5-NO_2
15	: 4-$OCOCH_3$
21	: 4-OH

Scheme 4. Hydrolysis of 3-acetylbenz[*d*]oxazol-2(3*H*)-ones **11–15** to benz[*d*]oxazol-2(3*H*)-ones **17–21**.

Table 2. Hydrolysis of 3-acetylbenz[*d*]oxazol-2(3*H*)-one (**6–10**) with 5(N) aqueous hydrochloric acid at 85 °C for 6 h

Substrate	R	Product	Mp (°C)	Yield (%)
11	H	**17**	141–142	49
12	5-Cl	**18**	193–194	76
13	5-Br	**19**	212–213	91
14	5-NO_2	**20**	230–231	80
15	6-OH	**21**	286–290	65

well, particularly because NO_2 and OH are in mutually complementary positions. This electronic effect should therefore reduce the capacity of OH to lend anchimeric assistance. 5-Nitrosalicylic acid was converted to **22** following Weinstock's protocol. Compound **22** was heated under reflux in dry toluene for 10 h. Subsequent removal of the solvent under reduced pressure produced a mixture of 5-nitrobenz[*d*]isoxazol-3(2*H*)-one (**23**) and 2-hydroxy-5-nitrophenyl isocyanate (**24**). ^{1}H NMR and ^{13}C NMR spectra of this mixture were recorded before any attempt of chromatographic separation. Subsequent column chromatography of this mixture over silica gel, with the provision of removing the solvent from the eluents under reduced pressure at 25 °C, led to the separation of two components, 5-nitrobenz[*d*]-isoxazol-3(2*H*)-one (**23**) and 5-nitrobenz[*d*]oxazol-2(3*H*)-one (**20**), in an approximately 1:1 ratio. The latter is produced as a silica-gel-mediated change of 2-hydroxy-5-nitrophenyl isocyanate (**24**) at room temperature (Scheme 5). Compound **23**, crystallized as **23**–C_2H_5OH, corresponded to the following ^{1}H NMR ($CDCl_3$) and ^{13}C NMR ($CDCl_3$) assignments: δ_H 1.38 (t, 3H, *J* 7.2 Hz, C**H**$_3$ of ethanol), 4.39 (q, 2H, *J* 7.2 Hz, C**H**$_2$ of ethanol), 6.96 (d, 1H, J_o 9.2 Hz, **H**-7), 8.20 (dd, 1H, J_o 9.2 Hz and J_m 2.9 Hz, **H**-6), 8.64 (d, 1H, J_m 2.9 Hz, **H**-4), 11.43 (s, 1H, -N**H**) and δ_C 168.78 and 166.18 (both s,



Scheme 5. Conversion of 5-nitrosalicylic acid to a mixture of 5-nitrobenz[*d*]isoxazol-3(2*H*)-one (**23**) and 5-nitrobenz[*d*]oxazol-2(3*H*)-one (**20**).

C-2 and **C**-7a), 139.99 (s, **C**-5), 130.17 (d, **C**-4), 126.34 (d, **C**-6), 118.39 (d, **C**-7), 112.31 (s, **C**-3a), 62.51 (t, $\mathbf{C}H_2$-OH), 13.91 (q, $\mathbf{C}H_3$ of ethanol).

In conclusion, we have successfully generated a protocol of converting 2-hydroxybenzoyl azides to 3-acetylbenz[*d*]oxazole-2(3*H*)-ones and their acid-catalyzed hydrolysis to benz[*d*]oxazol-2(3*H*)-ones. In a variation, upon heating in refluxing toluene, 2-hydroxy-5-nitrobenzoyl azide underwent a change to produce a mixture of two products that, on chromatographic separation over silica gel, gave 5-nitrobenz[*d*]oxazole-2(3*H*)-one and 5-nitrobenz[*c*]isoxazole-3(2*H*)-one.

EXPERIMENTAL

The melting points are uncorrected. IR spectra were recorded as KBr pellets on a Perkin-Elmer-782 spectrophotometer, and UV spectra of ethanolic solution of the compounds were recorded on a Hitachi U-2000 spectrophotometer. The ^{1}H NMR spectra in $CDCl_3$ (if not mentioned otherwise) were run on a Bruker AM-300L instrument operating at 300 MHz with tetramethylsilane (TMS) as internal standard, and the ^{13}C NMR spectra were run in $CDCl_3$(if not mentioned otherwise) on the same instrument operating at 75 MHz. The degree of proton attachment of the carbons was verified using the distortionless enhancement by polarization transfer (DEPT-135) sequence. Silica gel (60–120 mesh) was used for chromatographic purification and separation. The solvents used were dried and distilled before use. Light petrol refers to one with a boiling range 60–80 °C.

General Procedure for the Synthesis of 2-Acetoxybenzoyl Azide and Its Derivatives (6–10)

A solution of triethyl amine (14 mL, 0.1 mol) in acetone (170 mL) was added portionwise to a well-stirred solution of *o*-acetoxybenzoic acid compounds **1–5** (0.08 mol) in a mixture of acetone (50 mL) and water (15 mL) at −5 °C (placed in an ice–salt bath). The temperature of the reaction mixture was maintained at −5 °C, and a solution of ethyl chloroformate (0.08 mol) in acetone (17 mL) was subsequently added to it dropwise during 10 min. Stirring was continued at that temperature for an additional period of 30 min. Then, a cold solution of sodium azide (10.15 g, 0.15 mol) in water (50 mL) was added dropwise during 30 min to the well-stirred reaction mixture at − 5 °C, and the mixture was then stirred while maintaining the same temperature for an additional period of 1 h. The reaction mixture was poured into ice water (500 mL), and the oil was extracted with ether (3 × 100 mL). The combined ether extract was washed with water (2 × 15 mL) and dried over anhydrous sodium sulfate. The solvent was removed from the dried extract under reduced pressure from an ice–salt bath at − 5 °C, and the low-melting waxy residue as the crude title compound was immediately dissolved in dry toluene (50 mL) for its thermal conversion. The spectroscopic data, given here, were obtained using the waxy solid without purification. No elemental analysis was attempted.

Data

2-Acetoxybenzoyl azide (6). Low-melting waxy compound (yield 60%); mp 65 °C (dec); IR: ν (cm^{-1}) 2180, 1780, 1700, 1500, 1385; ^{1}H NMR: δ 2.36 (s, 3H,

-C**H**$_3$), 7.13 (d, 1H, *J* 7.8 Hz, **H**-3), 7.31 (t, 1H, *J* 7.8 Hz, **H**-5), 7.62 (t, 1H, *J* 7.8 Hz, **H**-4), 8.00 (d, 1H, *J* 7.8 Hz, **H**-6).

5-Chloro-2-acetoxybenzoyl azide (7). This semisolid mass could not be isolated and characterized; rather, it was immediately taken in dry toluene to use in the next step.

5-Bromo-2-acetoxybenzoyl azide (8). Fibrous, shining yellowish white material (yield 79%); mp 167–170 °C (dec); IR: ν (cm^{-1}) 2140, 1765, 1690, 1593, 1472, 1227, 1169; ^{1}H NMR: δ 9.11 (d, 1H, J_m 1.9 Hz, **H**-6), 7.70 (dd, 1H, J_o 8.6 Hz, J_m 2.0 Hz, **H**-4), 7.01 (d, 1H, J_o 8.6 Hz, **H**-3), 2.41 (s, 3H, C**H**$_3$); ^{13}C NMR : δ_c 168.98 and 168.96 (both s, both **C**=O), 149.99 (s, **C**-2), 137.81 (d, **C**-4), 134.28 (d, **C**-6), 125.92 (d, **C**-3), 125.16 (s, **C**-5), 119.03 (s, **C**-1), 20.79 (q, **C**H$_3$).

5-Nitro-2-acetoxybenzoyl azide (9). Yellowish solid (yield 66%); mp 146–148 °C(dec.); IR: ν (cm^{-1}) 3103, 2150, 1821 and 1775, 1696, 1621, 1534, 1476, 1352, 1316, 1237, 1180; ^{1}H NMR: δ 8.64 (s, 1H, **H**-6), 8.24 (d, 1H, J_o 8.7 Hz, **H**-4), 7.66 (d, 1H, *J* 8.7 Hz, **H**-3), 2.62 (s, 1H, C**H**$_3$); ^{13}C NMR (DMSO-d$_6$): δ_c 169.66, (s, CH$_3$**C**=O), 146.33 (s, **C**-2), 140.68 (s, **C**-5), 128.42 (s, **C**-1), 121.68 (d, **C**-6), 110.60 and 110.31 (both d, **C**-3, **C**-4), 24.51 (q, **C**H$_3$).

2,4-Diacetoxybenzoyl azide (10). Oily residue; IR: ν (cm^{-1}) 2137, 1804, 1737 and 1691.

General Procedure for the Synthesis of 3-Acetylbenz[*d*]oxazol-2(3*H*)-ones (11–15)

A solution of crude *o*-acetoxybenzoyl azides **6–10** (0.05 mol) in dry toluene (50 mL) was directly placed in a water bath whose temperature was increased slowly. At ~ 50 °C, the effervescence in dry toluene solution started. Effervescence was sustained by gradually increasing the temperature of the water bath. It took ~6 h for completion of the reaction, indicated by cessation of effervescence in boiling water (Table 1). Removal of the solvent from the reaction mixture under reduced pressure produced a colorless solid, which was crystallized from the benzene–petrol mixture.

Data

3-Acetylbenz[*d*]oxazol-2(3*H*)-ones (11). Fluffy white crystals (yield 91%); mp 85–86 °C; IR: ν (cm^{-1}) 3100, 3020, 1840 and 1800, 1725,1600, 1480, 1380, 1320; UV: λ_{max} (logϵ) 274.5 (3.25) nm; ^{1}H NMR: δ 2.75 (s, 3H, C**H**$_3$), 7.20–7.27(m, 3H, **H**-5, **H**-6 and **H**-7), 8.06 (m, 1H, **H**-4); ^{13}C NMR: δ_c 24.80(q, **C**H$_3$), 109.72 (d, **C**-7), 115.82 (d, **C**-4), 126.54 and 125.20 (each d, **C**-5 and **C**-6), 127.50 (s, **C**-3a), 142.00 (s, **C**-7a), 151.38 (s, **C**-2), 169.36 (s, CH$_3$**C**=O); HRMS: 177.04265 (177.042575 for $C_9H_7NO_3$); EI-MS (70 eV), *m*/*z*: 177 ($M^{+\cdot}$, 10.4%), 135 (100%), 91 (7.8%), 79 (14.9%). Found: C, 60.95; H, 3.88; N, 8.01. $C_9H_7NO_3$ requires C, 61.02; H, 3.95; N, 7.91%.

5-Chloro-3-acetylbenz[*d*]oxazol-2(3*H*)-ones (12). Colorless crystalline solid (yield 88%); mp 140 °C; IR: ν (cm^{-1}) 3118, 1831, 1727, 1478, 1380, 1306,

1249, 1150; ^{1}H NMR: δ 8.86 (d, 1H, J_m 2.1 Hz, **H**-4), 7.22 (dd, 1H, J_o 8.6 Hz, J_m2.1 Hz, **H**-6), 7.12 (d, 1H, J_o 8.6 Hz, **H**-7), 2.72 (s, 1H, C**H**$_3$); ^{13}C NMR: δ_c 168.98, (s, CH_3**C**=O), 151.09 (s, **C**-2), 140.68 (s, **C**-7a), 130.41 (s, **C**-5), 128.42 (s, **C**-3a), 125.26 (d, **C**-6), 116.39 (d, **C**-4), 110.55 (d, **C**-7), 24.52 (q, **C**H_3); EI-MS (70 eV), m/z: 211 ($M^{+\cdot}$, 72.5%), 169 (100%), 113 (71%). Found: C, 51.31; H, 2.66; N, 6.83. $C_9H_6NO_3Cl$ requires C, 51.06; H, 2.84; N, 6.62%.

5-Bromo-3-acetylbenz[*d*]oxazol-2(3*H*)-one (13). Shining white crystals (yield 85%); mp 158 °C; IR: ν (cm^{-1}) 3112, 1822, 1725, 1473, 1304, 1248, 1028; ^{1}H NMR: δ 8.22 (d, 1H, J_m 2.0 Hz, **H**-4), 7.38 (dd, 1H, J_o 8.6 Hz, J_m 2.0 Hz, **H**-6), 7.08 (d, 1H, J_o 8.6 Hz, **H**-7), 2.57 (s, 1H, C**H**$_3$); ^{13}CNMR : δ_c 169.02, (s, CH_3**C**=O), 150.98 (s, **C**-2), 141.19 (s, **C**-7a), 128.72 (s, **C**-3a), 128.25 (d, **C**-6), 119.14 (d, **C**-4), 117.51 (s, **C**-5), 111.07 (d, **C**-7), 24.54 (q, **C**H_3); HRMS: 254.95261 (254.95308 for $C_9H_6NO_3Br$); EI-MS (70 eV), m/z: 255 and 257 ($M^{+\cdot}$ 12.3% and 11.9% respectively), 213 and 215 (100% and 97.7% respectively), 157 and 159 (9.3% and 8.9%). Found: C, 42.40; H, 2.49; N, 5.30. $C_9H_6NO_3Br$ requires C, 42.19; H, 2.34; N, 5.47%.

5-Nitro-3-acetylbenz[*d*]oxazol-2(3*H*)-one (14). Yellow crystalline solid (yield 85%); mp 166–168 °C (aqueous ethanol); IR: ν (cm^{-1}) 3142, 1820, 1731, 1607, 1539, 1476, 1377, 1339, 1267, 1214, 1156; ^{1}H NMR (DMSO-d_6): δ 8.60 (d, 1H, J_m 2.3 Hz, **H**-4), 8.24 (dd, 1H, J_o 8.9 Hz, J_m 2.3 Hz, **H**-6), 7.66 (d, 1H, J_o 8.9 Hz, **H**-7), 2.61 (s, 3H, C**H**$_3$); ^{13}C NMR (DMSO-d_6): δ_c 169.77 (s, CH_3**C**=O), 150.77 (s, **C**-2), 146.34 (s, **C**-7a), 144.16 (s, **C**-5), 128.52 (s, **C**-3a), 121.69 (d, **C**-6), 110.61 and 110.31 (both d, **C**-4 and **C**-7), 24.52 (q, **C**H_3); HRMS: 222.02754 (222.02764 for $C_9H_6N_2O_5$); EI-MS (70 eV), m/z: 222 ($M^{+\cdot}$ 26.4%), 180 (100%), 164 (7.7%), 150 (15.4%), 134 (14.8%). Found: C, 48.53; H, 2.52; N, 12.80. $C_9H_6N_2O_5$ requires C, 48.65; H, 2.70; N, 12.61%.

6-Acetoxy-3-acetylbenz[*d*]oxazol-2(3*H*)-one (15). Greyish white solid (yield 82%); mp 194–196 °C (chloroform-petrol); IR: ν (cm^{-1}) 3027, 1644, 1440, 1331, 1240, 1153, 1093; ^{1}H NMR (DMSO-d_6): δ 7.99 (d, 1H, J_o8.6 Hz, **H**-4), 7.31 (d, 1H, J_m 2.2 Hz, **H**-7), 7.01 (dd, 1H, J_o 8.6 Hz, J_m 2.2 Hz, **H**-5), 2.57 (s, 3H, NCOC**H**$_3$), 2.29 (s, 3H, C**H**$_3$COO); ^{13}C NMR (DMSO-d_6): δ_c 169.52 and 169.15 (both s, two CH_3**C**O), 151.16 (s, **C**-2), 147.44 (s, **C**-7a), 142.02 (s, **C**-6), 125.62 (s, **C**-3a), 117.80 (d, **C**-4), 115.36 (d, **C**-5), 104.96 (d, **C**-7), 24.00 (q, **C**H_3CON), 20.81 (q, **C**H_3COO). Elemental analysis was not attempted due to failure to prepare a sample of analytical purity.

General Procedure for the Synthesis of Benz[*d*]oxazol-2(3*H*)-ones (17–21)

A suspension of 3-acetylbenz[*d*]oxazol-2-ones (**6–10**) (0.04 mol) in 5% aqueous hydrochloric acid (250 mL) was stirred at ~90 °C for 8 h. On cooling, white solid precipitated out and was collected by filtration. The solid was washed with cold 2% aqueous sodium bicarbonate solution (2 × 15 mL) followed by cold water (2 × 10 mL) and recrystallized.

Data

Benz[*d*]oxazol-2(3*H*)-one (17). Colorless shining crystals (yield 49%); mp 141–142 °C[20,21] (lit. mp 138 °C and 143–145 °C respectively, chloroform-petrol); IR: ν (cm^{-1}) 3500, 3300–3200, 1790, 1750, 1500, 1415, 1325, 1270, 1160; UV: $\lambda_{max}(\log\epsilon)$ 274.0 (3.25), 225.5(3.49) nm; λ_{min} ($\log\epsilon$) 242.0 (2.66), 217.5(3.41) nm; ^{1}H NMR: δ 6.03 (br. s, 1H, N-**H**), 7.10–7.26 (m, 4H, aromatic protons); ^{13}C NMR: δ_c 155.80 (s, **C**-2), 144.06 (s, **C**-7a), 129.43 (s, **C**-3a), 124.11 and 122.76 (each d, **C**-5 and **C**-6), 110.17 (d, **C**-4), 109.96 (d, **C**-7); EI-MS (70 eV), *m/z*: 135 ($M^{+\cdot}$, 100%), 91 (59%), 79 (80.5%). Found: C, 62.10; H, 3.81; N, 10.15. $C_7H_5NO_2$ requires C, 62.22; H, 3.70; N, 10.37%.

5-Chlorobenz[*d*]oxazol-2(3*H*)-one (18). Shining white crystals (yield 76%); mp 193–194 °C[21,22](lit. mp 190–191 °C and 186–188 °C respectively, ethanol); IR: ν (cm^{-1}) 3450, 3157, 1773, 1615, 1300, 1147; ^{1}H NMR: δ 11.76 (br. s, 1H, N-**H**), 7.21(dd, 1H, J_o 8.3 Hz, J_m 3.1 Hz **H**-6), 7.02–7.06 (m, 2H, **H**-4 and **H**-7); ^{13}C NMR: δ_c 154.30, (s, **C**-2), 142.21 (s, **C**-7a), 131.78 (s, **C**-5), 127.87 (s, **C**-3a), 121.51 (d, **C**-6), 110.72 (d, **C**-4), 109.84 (d, **C**-7); EI-MS (70 eV), *m/z*: 169 ($M^{+\cdot}$, 100%), 113 (71.8%), 78 (90.6%). Found: C, 49.65; H, 2.24; N, 8.46. $C_7H_4NO_2Cl$ requires C, 49.56; H, 2.36; N, 8.26%.

5-Bromobenz[*d*]oxazol-2(3*H*)-one (19). Shining white crystals (yield 91%); mp 212–213 °C[23] (lit. mp 218–220 °C, ethanol); IR: ν (cm^{-1}) 3156, 3054, 1772, 1612, 1473, 1295, 1254, 1149; ^{1}H NMR : δ 7.97 (d, 1H, *J* 2.1 Hz, **H**-4), 7.45 (dd, 1H, J_o 8.5 Hz, J_m 2.1 Hz, **H**-6), 7.36 (d, 1H, J_o 8.5 Hz, **H**-7); ^{13}C NMR (DMSO-d_6): δ_c 154.15, (s, **C**-2), 142.65 (s, **C**-7a), 132.12 (s, **C**-3a), 115.41 (s, **C**-5), 124.45 (d, **C**-6), 111.60 and 111.32 (both d, **C**-4 and **C**-7); EI-MS (70 eV), m/z: 213 and 215 ($M^{+\cdot}$,100%), 157 and 159 (69.6% and 70.8% respectively). Found: C, 39.04; H, 2.04; N, 6.22. $C_7H_4NO_2Br$ requires C, 39.25; H, 1.87; N, 6.54%.

5-Nitrobenz[*d*]oxazol-2(3*H*)-one (20). Yellow solid (yield 80%); mp 230–231 °C[22,24] (lit. mp 228–230 °C and 239–240 °C, ethanol); IR: ν (cm^{-1}) 3080–3210, 1772.0, 1629.4, 1523.5, 1473.9, 1396.9, 1346.7, 1265.8, 1150.7, 1067.8; ^{1}H NMR: δ 7.93 (dd, 1H, J_o 8.9 Hz and J_m 2.4 Hz, **H**-6), 7.73 (d, 1H, J_m 2.4 Hz, **H**-4), 7.40 (d, 1H, J_o 8.9 Hz, **H**-7); ^{13}C NMR: δ_c 153.97 (s, **C**-2), 147.81 (s, **C**-5), 143.94 (s, **C**-7a), 131.21 (s, **C**-3a), 118.48 (d, **C**-6), 109.67 (d, **C**-4), 104.98 (d, **C**-7). Found: C, 46.42; H, 2.43; N, 15.34. $C_7H_4N_2O_4$ requires C, 46.67; H, 2.22; N, 15.56%.

6-Hydroxybenz[*d*]oxazol-2(3*H*)-one (21). Greyish white solid (yield 65%); mp 286–290 °C[20] (lit. mp 265 °C, ethanol); IR: ν (cm^{-1}) 3348 and 3217, 1737, 1640, 1553, 1497, 1405, 1328, 1234, 1107; ^{1}H NMR (DMSO-d_6): δ 11.26 (br. s, 1H, O**H**), 9.38 (br. s, 1H, N**H**), 6.82 (d, 1H, J_o8.2 Hz, **H**-4), 6.66 (d, 1H, J_m 2.1 Hz, **H**-7), 6.51 (dd, 1H, J_o 8.3 and J_m 2.1 Hz, **H**-5); ^{13}C NMR (DMSO-d_6): δ_c 154.89 and 153.14, (both s, **C**-2 and **C**-6), 144.14 (s, **C**-7a), 122.37 (s, **C**-3a), 110.90 and 109.90 (both d, **C**-4 and **C**-5), 99.06 (s, **C**-7). Found: C, 55.42; H, 3.51; N, 9.06. $C_7H_5NO_3$ requires C, 55.63; H, 3.31; N, 9.27%.

Synthesis of 2-Hydroxy-5-nitrobenzoyl Azide (22)

This was achieved starting from 5-nitrosalicylic acid and following the general procedure for the synthesis of 2-acetoxybenzoyl azide and its derivatives; it was crystallized as **22**–C_2H_5OH (yield 23%); mp 280–281 °C; IR: ν (cm^{-1}) 3400, 3080, 2160, 1700, 1615, 1560, 1510, 1485, 1450, 1350, 1325, 1310, 1260, 1230; ^{1}H NMR: δ 1.44 (t, 3H, *J* 7.0 Hz, C**H**$_3$ of ethanol), 4.99 (q, 2H, *J* 7.0 Hz, C**H**$_2$OH), 7.08 (d, 1H, J_o 9.2 Hz, **H**-3), 8.33 (dd, 1H, J_o 9.2 Hz, J_m 2.8 Hz, **H**-4), 8.79 (d, 1H, J_m 2.8 Hz, **H**-6), 11.45 (s, O**H**).

Synthesis of 5-Nitrobenz[*d*]oxazol-2(3*H*)-one (20) and 5-Nitro-benz[*d*]isoxazol-3(2*H*)-one (23) from 22

The crude yellow material of 2-hydroxy-5-nitrobenzoyl azide (**22**) (2.0 g, 0.009 mol) was heated in toluene (50 mL) under reflux for 10 h. The solvent was removed from the reaction mixture at 25 °C under reduced pressure to get an yellow solid as a mixture of two products, **23** and 5-nitro-2-hydroxyphenyl isocyanate (**24**); its IR spectrum (as KBr pellet) showed absorptions at 3350–3380 (br.), 2160, and 1680–1710 cm^{-1}. ^{1}H NMR spectrum analyses for two sets of protons corresponded to two compounds in a ~ 1:1 ratio.

Set I: δ 8.51 (d, J_m 3.6 Hz), 7.76 (dd, J_0 9.0 Hz, J_m 2.8 Hz), and 6.89 (d, J_0 9.0 Hz) for the protons attached to C-4, C-6, and C-7 respectively of 5-nitrobenz[*d*]isoxazol-3(2*H*)-one (**23**).

Set II: δ 7.44 (s), 7.55 (distorted d) and 6.16 (d, J_0 9.0 Hz) corresponded to 5-nitro-2-hydroxyphenyl isocyanate (**24**).

This mixture of products was separated by column chromatography on silica gel using 20% methanolic chloroform for elution. Two products, 5-nitrobenz[*d*]oxazol-2(3*H*)-one (**20**) and 5-nitrobenz[*d*]isoxazol-3(2*H*)-one (**23**), were obtained in an almost 1:1 ratio; **20** was obtained first, followed by **23**.

5-Nitrobenz[*d*]oxazol-2(3*H*)-one (20). Mp 230–234 °C, IR spectrum superimposable with that of **20** prepared from hydrolysis of **14**; ^{1}H NMR: δ 7.40 (d, 1H, J_0 8.9 Hz, **H**-7), 7.73 (d, 1H, J_m 2.4 Hz, **H**-4), 7.93 (dd, 1H, J_o 8.9 Hz and J_m 2.4 Hz, **H**-6). ^{13}C NMR: δ_c 153.98 (s, **C**-2), 147.81 (s, **C**-5), 143.94 (s, **C**-7a), 131.21 (s, C-3a), 118.48 (d, C-6), 109.67 (d, C-4), 104.98 (d, C-7).

5-Nitrobenz[*d*]isoxazol-3(2*H*)-one (23). Compound **23** crystallized as **23**–C_2H_5OH, mp 206–207 °C[25] (lit. mp 205–207 °C); ^{1}H NMR: δ 1.38 (t, 3H, *J* 7.2 Hz, C**H**$_3$ of ethanol), 4.39 (q, 2H, *J* 7.2 Hz, -C**H**$_2$ of ethanol), 6.96 (d, 1H, J_o 9.2 Hz, **H**-7), 8.20 (dd, 1H, J_o 9.2 Hz and J_m 2.9 Hz, **H**-6), 8.64 (d, 1H, J_m 2.9 Hz, **H**-4), 11.43 (1H, s, N**H**). ^{13}C NMR: δ_c 168.78 and 166.18 (both s, **C**-2 and **C**-7a), 139.99 (s, **C**-5), 130.17 (d, **C**-4), 126.34 (d, **C**-6), 118.39 (d, **C**-7), 112.31 (s, **C**-3a), 62.51 (t, CH_2-OH), 13.91 (q, **C**H$_3$ of ethanol).

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