SUPPORTING INFORMATION

β -Cyclodextrin in water: Highly Versatile and Green Approach for Biomimetic

Regioselective Ring Opening of Chalcone Epoxides with Nitrogen Heterocycles

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1. General methods

All the required chemicals were purchased from Merck and Aldrich Chemical Company. Pre-coated aluminium sheets (silica gel 60 F254, Merck) were used for thin-layer chromatography (TLC) and spots were visualized under UV light. Silica gel column chromatography was performed using silica gel 60–120 mesh size (RANKEM Limited). IR spectra were recorded with KBr on Thermo Nicolet FT-IR spectrophotometer. ^1H NMR and ^{13}C NMR spectra were recorded on Bruker Spectrospin DPX 500 MHz spectrometer using CDCl_3 as a solvent and trimethylsilane (TMS) as an internal standard. Spectra were processed using Bruker Topspin[®] 3.0.b.8. Splitting patterns are designated as follows; s = singlet, d = doublet, dd = doublets of doublet, m = multiplet, br = broad. Chemical shift (δ) values are given in ppm. Mass spectra were collected using a direct inlet system (70 eV) with a VL detector (ES, 4000 V) on Perkin Elmer GC-MS. High-resolution mass spectra (HRMS) were obtained on a Brüker micrOTOF[™]-QII mass spectrometer (ESIMS).

2. General procedure for the synthesis of compounds (3a-u):

β -CD (0.1 mmol) was dissolved in water (15 ml) at 60 $^\circ\text{C}$ until a clear solution was obtained, then the chalcone epoxide **2a-q** (1 mmol) was added slowly with stirring and the mixture allowed to cool to room temperature. The nucleophile **2a-c** (1 mmol) was then added and the stirring was continued at room temperature until the reaction was completed. The organic material was extracted with EtOAc (3 $\times$ 25 mL). The organic phase was separated and filtered β -CD was recovered by filtration and reused. The organic phase was then dried over Na_2SO_4 , and the solvent was removed under vacou. The crude product was purified by silica gel column chromatography using ethyl hexane/ethyl acetate (8:2) as the eluent if needed.

3. Characterization data of synthesized compounds

Phenyl-3-phenyl-oxiran-2-yl-methanone (**1a**):^[2a]

Yield: 86%; white crystalline solid; mp: 84-85 °C. ¹H NMR (CDCl₃, 500 MHz, ppm): δ 4.01 (d, *J* = 1.5 Hz, 1H), 4.23 (d, *J* = 1.5 Hz, 1H), 7.22-7.45 (m, 8H), 7.94 (d, *J* = 7.8 Hz, 2H). IR (KBr) ν: 3040, 1660, 1404, 1221 cm⁻¹.

(4-chlorophenyl)-3-phenyl-oxiran-2-yl-methanone (**1b**):^[3]

Yield: 85%; white crystalline solid; mp 63-64 °C; ¹H NMR (CDCl₃, 500 MHz, ppm) δ 4.07 (d, *J* = 2.0 Hz, 1H), 4.23 (d, *J* = 2.0 Hz, 1H), 7.35-7.41 (m, 5H), 7.45-7.47 (m, 2H), 7.96-7.98 (m, 2H). IR (KBr) ν: 3040, 1680, 1566, 1421, 1206 cm⁻¹.

Phenyl-3-(4-chlorophenyl)-oxiran-2-yl-methanone (**1c**):^[3]

Yield: 83%; white crystalline solid; mp 50-51 °C; ¹H NMR (CDCl₃, 500 MHz, ppm) δ 4.06 (d, *J* = 1.6 Hz, 1H), 4.25 (d, *J* = 1.6 Hz, 1H), 7.30-7.32 (m, 2H), 7.37-7.39 (m, 2H), 7.48-7.52 (m, 2H), 7.61-7.65 (m, 1H), 7.99-8.01 (m, 2H). IR (KBr) ν: 3010, 1660, 1546, 1411, 1201 cm⁻¹.

(4-chlorophenyl)-3-(4-chlorophenyl)-oxiran-2-yl-methanone (**1d**):^[1]

Yield: 89%; White crystalline solid; mp 112-118 °C. ¹H NMR (CDCl₃, 500 MHz, ppm) δ 4.06 (d, *J* = 2 Hz, 1H), 4.18 (d, *J* = 2 Hz, 1H), 7.30 (d, *J* = 11 Hz, 2H), 7.40 (d, *J* = 11 Hz, 2H), 7.47 (d, *J* = 8.5 Hz, 2H), 7.96 (d, *J* = 8.5 Hz, 2H). IR (KBr) ν: 3039, 1675, 1587, 1400, 1236 cm⁻¹. GC-MS (m/z): 292.

(4-Chlorophenyl)-3-(3-nitrophenyl)-oxiran-2-yl-methanone (**1e**):^[3]

Yield: 87%; White crystalline solid; mp 64-65 °C. ¹H NMR (CDCl₃, 500 MHz, ppm) δ 4.24 (d, *J* = 1.5 Hz, 1H), 4.27 (d, *J* = 1.5

Hz, 1H), 7.52 (m, 2H), 7.63 (m, 1H), 7.74 (d, $J = 7.5$ Hz, 1H), 8.01 (dd, $J = 7.0, 1.5$ Hz, 2H), 8.27 (d, $J = 8.5$ Hz, 2H). IR (KBr) ν : 3091, 1665, 1537, 1358, 1212 cm^{-1} .

p-tolyl-3-(4-chlorophenyl)-oxiran-2-yl-methanone (1f):^[1]

Yield: 87%; white crystalline solid; mp 110-115 $^{\circ}\text{C}$; ^1H NMR (CDCl_3 , 500 MHz, ppm) δ 2.37 (s, 3H), 4.04 (d, $J = 1.8$ Hz, 1H), 4.24 (d, $J = 2.1$ Hz, 1H), 7.21-7.27 (m, 4H), 7.46 (dd, $J = 7.0, 1.8$ Hz, 2H), 7.96 (dd, $J = 6.6, 2.1$ Hz, 2H). IR (KBr) ν : 3011, 1686, 1560, 1403, 1207 cm^{-1} .

p-tolyl-3-(4-chlorophenyl)-oxiran-2-yl-methanone (1g):^[1]

Yield: 84%; white crystalline solid; mp 54-56 $^{\circ}\text{C}$; ^1H NMR (CDCl_3 , 500 MHz, ppm) δ 2.25 (s, 3H), 4.12 (d, $J = 1.6$ Hz, 1H), 4.31 (d, $J = 1.6$ Hz, 1H), 7.6-7.2 (m, 6H), 8.05-7.99 (m, 2H). IR (KBr) ν : 3050, 1677, 1600, 1400, 1280, 1240, 1180, 1120 cm^{-1} .

(4-fluorophenyl)-3-(chlorophenyl)-oxiran-2-yl-methanone (1h):

Yield: 88%; white crystalline solid; mp 66-67 $^{\circ}\text{C}$; ^1H NMR (CDCl_3 , 500 MHz, ppm) δ 4.07 (d, $J = 2.0$ Hz, 1H), 4.26 (d, $J = 2.0$ Hz, 1H), 7.07-7.11 (m, 2H), 7.33-7.37 (m, 2H), 7.48-7.51 (m, 2H), 7.99-8.02 (m, 2H). IR (KBr) ν : 3011, 1683, 1400, 1243, 1018 cm^{-1} .

(4-bromophenyl)-3-phenyl-oxiran-2-yl-methanone (1i):^[2a]

Yield: 76%; white crystalline solid; mp 65-66 $^{\circ}\text{C}$; ^1H NMR (500 MHz, CDCl_3 , ppm) δ 4.07 (d, $J = 1.5$ Hz, 1H), 4.27 (d, $J = 1.5$ Hz, 1H), 7.26-7.38 (m, 4H), 7.51-7.53 (m, 2H), 7.65 (m, 1H), 8.01 (dd, $J = 7.8, 1.2$ Hz, 2H). IR (KBr) ν : 3050, 1680, 1452, 1258 cm^{-1} .

(4-bromophenyl)-3-(p-tolyl)-oxiran-2-yl-methanone (1j):^[2b]

Yield: 88%; white crystalline solid; mp 100-101 $^{\circ}\text{C}$; ^1H NMR (CDCl_3 , 500 MHz, ppm) δ 2.25 (s, 3H), 4.12 (d, $J = 1.6$ Hz, 1H),

4.32 (d, $J=1.6$ Hz, 1H), 7.7–7.17 (m, 6H), 8.25–8.08 (m, 2H).

p-tolyl-3-(4-bromophenyl)-oxiran-2-yl-methanone (1k):^[1]

Yield: 90%; White crystalline solid; mp 85-86 °C. ¹H NMR (CDCl₃, 500 MHz, ppm) δ 2.29 (s, 3H), 4.07(d, $J = 2.0$ Hz, 1H), 4.20 (d, $J = 2.0$ Hz, 1H), 7.11-7.19 (m, 4H), 7.38-7.41 (m, 2H),

7.91-8.03 (m, 2H). IR (KBr) ν : 3010, 1664, 1421, 1223, 1021 cm⁻¹.

(4-methoxyphenyl)-3-(4-bromophenyl)-oxiran-2-yl-methanone (1m):^[2a]

Yield: 81%; white crystalline solid; ¹H NMR (CDCl₃, 500 MHz, ppm) δ 3.88 (s, 3H), 4.05 (d, $J = 1.8$ Hz, 1H), 4.21 (d, $J = 1.8$ Hz, 1H), 6.96 (d, $J = 8.7$ Hz, 2H); 7.29-7.39 (m, 4H), 8.00 (d, $J = 7.8$ Hz, 2H). IR (KBr) ν : 3045, 1634, 1421, 1232, 1064 cm⁻¹.

naphthalen-2-yl-3-phenyl-oxiran-2-yl-methanone (1n):^[4]

Yield: 91%; light yellow solid; mp 80-81 °C; ¹H NMR (CDCl₃, 500 MHz, ppm) δ 4.16 (d, $J = 2$ Hz, 1H), 4.44 (d, $J = 1.6$ Hz, 1H), 7.40–7.45 (m, 5H), 7.55–7.59 (m, 1H), 7.62–7.64 (m, 1H), 7.88–

7.97 (m, 3H), 8.05–8.07 (m, 1H), 8.58 (s, 1H). IR (KBr) ν : 3010, 1664, 1421, 1223, 1021 cm⁻¹.

naphthalen-2-yl-3-(p-tolyl)-oxiran-2-yl-methanone (1o):

Yield: 87%; light yellow solid; mp 74-75 °C; ¹H NMR (CDCl₃, 500 MHz, ppm) δ 2.13 (s, 3H), 4.07 (d, $J = 2.0$ Hz, 1H), 4.20 (d, $J = 2.0$ Hz, 1H), 7.40 (d, $J = 8.5$ Hz,

2H), 7.55–7.59 (m, 1H), 7.62–7.64 (m, 1H), 7.71 (d, $J = 8.5$ Hz, 2H), 7.88–7.97 (m, 3H), 8.05–8.07 (m, 1H), 8.58 (s, 1H). IR (KBr) ν : 3040, 1660, 1404, 1221 cm⁻¹.

naphthalen-2-yl-3-(4-methoxyphenyl)-oxiran-2-yl-methanone (1p):^[6]

Yield: 85%; light yellow solid; mp 81-82 °C; ¹H NMR (CDCl₃,

500 MHz, ppm) δ 3.88 (s, 3H), 4.05 (d, J = 1.8 Hz, 1H), 4.21 (d, J = 1.8 Hz, 1H), 8.58 (s, 1H), 8.05–8.07 (m, 1H), 7.88–7.97 (m, 3H), 7.72–7.76 (d, J = 8.5 Hz, 2H), 7.62–7.64 (m, 1H), 7.55–7.59 (m, 1H), 6.96 (d, J = 9.2 Hz, 2H). IR (KBr) ν : 3040, 1660, 1404, 1221 cm^{-1} .

naphthalen-2-yl-3-(4-chlorophenyl)-oxiran-2-yl-methanone (1q):^[5]

Yield: 90%; light yellow solid; mp 81–82 $^{\circ}\text{C}$; ^1H NMR (CDCl_3 , 500 MHz, ppm) δ 4.12 (d, J = 1.8 Hz, 1H), 4.31 (d, J = 1.8 Hz, 1H), 7.47 (d, J = 8.5 Hz, 2H), 7.55–7.59 (m, 1H), 7.62–7.64 (m, 1H), 7.88–7.97 (m, 3H), 7.96 (d, 2H, J = 8.5 Hz), 8.05–8.07 (m, 1H), 8.58 (s, 1H). IR (KBr) ν : 3039, 1675, 1587, 1430, 1400, 1236, 1092 cm^{-1} .

2-hydroxy-1,3-diphenyl-3-(1H-pyrrol-2-yl)propan-1-one (3a)

Yield: 75%; light yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm): δ 3.77 (br, 1H, D_2O -exchangeable, OH), 4.75 (d, J = 7.5 Hz, 1H), 5.89 (dd, J = 1.5, 7.5 Hz, 1H), 6.15 (dd, J = 3.6, 5.4 Hz, 1H), 6.18 (dd, J = 2.5, 5.4 Hz, 1H), 6.66 (dd, J = 2.5, 3.6 Hz, 1H), 7.11–7.45 (m, 10H), 8.19 (br, 1H, D_2O -exchangeable, NH). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 43.5, 86.7, 106.1, 108.4, 118.6, 126.0, 126.4, 127.2, 128.0, 129.1, 129.7, 130.0, 132.3, 136.2, 200.4. IR (KBr) ν : 3412 (OH and NH), 3124, 2923, 1680 ($>\text{C}=\text{O}$), 1636, 1443, 1270, 1122, 765 cm^{-1} . HR-MS (m/z) for $\text{C}_{19}\text{H}_{17}\text{NNaO}_2$ Calcd. 314.1151; found 314.1154.

2-hydroxy-3-(1H-indol-3-yl)-1,3-diphenylpropan-1-one (3b):

Yield: 95%; yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm): δ 3.72 (br, 1H, D_2O -exchangeable, OH), 4.79 (d, J = 7.5 Hz, 1H), 5.87 (d, J = 7.5 Hz, 1H), 6.43–6.46 (m, 1H), 7.12–7.20 (m, 5H), 7.93–7.95 (m, 2H), 7.54 (t, J = 7.5 Hz, 2H), 7.62–7.71 (m, 3H), 7.94 (d, J = 7.5 Hz, 2H), 8.19 (br, 1H, D_2O -exchangeable, NH). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 47.1, 76.1, 100.8, 107.6, 111.1, 116.8, 118.9, 112.1, 123.1, 126.9, 127.9,

128.7, 129.3, 132.3, 134.0, 136.0, 137.7, 165.3, 200.4. IR (KBr) ν : 3412 (OH and NH), 3124, 2923, 1680 (C=O), 1626, 1452, 1258, 1106, 744, 697 cm^{-1} . HR-MS (m/z) for $\text{C}_{23}\text{H}_{19}\text{NNaO}_2$ ($\text{M}+\text{Na}^+$) Anal. Calcd. 364.1307; found 364.1301.

2-hydroxy-3-(2-methyl-1H-indol-3-yl)-1,3-diphenylpropan-1-one (3c):

Yield: 79%; yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm): δ 2.11 (s, 3H), 3.81 (br, 1H, D_2O -exchangeable, OH), 4.79 (d, $J = 7.5$ Hz, 1H), 5.87 (dd, $J = 7.5, 1.5$ Hz, 1H), 6.43-6.46 (m, 1H), 7.12-7.17 (m, 2H), 7.12-7.17 (m, 3H), 7.93-7.95 (m, 2H), 7.54 (t, $J = 7.5$ Hz, 2H), 7.62-7.71 (m, 2H), 7.94 (d, $J = 7.5$ Hz, 2H), 8.19 (br, 1H, D_2O -exchangeable, NH). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 22.0, 47.1, 76.1, 100.8, 107.6, 111.1, 116.8, 118.9, 112.1, 123.1, 126.9, 127.9, 128.7, 129.3, 132.3, 134.0, 136.0, 137.7, 165.3, 200.4. IR (KBr) ν : 3421 (OH and NH), 3131, 2973, 1675 (C=O), 1630, 1464, 1274, 1123, 764, 667 cm^{-1} . HR-MS (m/z) for $\text{C}_{24}\text{H}_{21}\text{NO}_2$ ($\text{M}+\text{Na}^+$) Anal. Calcd. 378.1464; found 378.1459.

1-(4-chlorophenyl)-2-hydroxy-3-(1H-indol-3-yl)-3-phenylpropan-1-one (3d):

Yield: 94%; yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm): δ 3.65 (br, 1H, D_2O -exchangeable, OH), 4.73 (d, $J = 7.5$ Hz, 1H), 5.81 (dd, $J = 2, 7.5$ Hz, 1H), 6.94-6.99 (m, 3H), 7.12-7.18 (m, 5H), 7.34 (d, $J = 8.5$ Hz, 1H), 7.67-7.78 (m, 3H), 7.86 (d, $J = 8.5$ Hz, 2H), 8.16 (br, 1H, D_2O -exchangeable, NH). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 47.2, 76.1, 111.1, 116.56, 118.9, 119.5, 122.2, 123.1, 126.8, 127.2, 128.0, 129.2, 129.4, 130.0, 132.6, 136.0, 137.6, 140.5, 199.3. IR (KBr) ν : 3414 (OH), 3328 (NH), 3058, 2923, 1680 (C=O), 1589, 1400, 1262, 1093, 742, 704 cm^{-1} . HR-MS (m/z) for $\text{C}_{23}\text{H}_{18}\text{ClNNaO}_2$ ($\text{M}+\text{Na}^+$) Anal. calcd. 398.0918; found 398.0915.

3-(4-chlorophenyl)-2-hydroxy-3-(1H-indol-3-yl)-1-phenylpropan-1-one (3e):

Yield: 93%; yellow solid; mp: 94-96⁰C; ¹H NMR (CDCl₃, 500 MHz, ppm): δ 3.80 (br, 1H, D₂O-exchangeable, OH), 4.74 (d, *J* = 7 Hz, 1H), 5.85 (d, *J* = 7 Hz, 1H), 6.88 (dd, *J* = 2, 8.5 Hz, 2H), 6.93 (td, *J* = 1, 7 Hz, 1H), 7.08-7.14 (m, 4H), 7.29 (d, *J* = 8.5 Hz, 1H), 7.49 (t, *J* = 7.5 Hz, 2H), 7.62-7.65 (m, 2H), 7.90 (dd, *J* = 1, 3.5 Hz, 2H), 8.22 (br, 1H, D₂O-exchangeable, NH). ¹³C NMR (CDCl₃, 125 MHz, ppm): δ 46.5, 75.9, 111.3, 116.3, 118.8, 119.5, 122.3, 123.2, 126.7, 128.1, 128.7, 129.2, 130.6, 132.9, 134.0, 134.2, 136.1, 136.4, 200.3. IR (KBr) ν : 3419 (NH), 3353 (OH), 3050, 2900, 1672 (C=O), 1488, 1403, 1264, 1090, 982, 778, 740, 690. HR-MS(*m/z*) for C₂₃H₁₈ClNNaO₂ (M+Na⁺) Anal. calcd. 398.0918; found 398.0919.

1,3-bis(4-chlorophenyl)-2-hydroxy-3-(1H-indol-3-yl)propan-1-one (3f):

Yield: 93%; yellow semi solid; ¹H NMR (CDCl₃, 500 MHz, ppm): δ 3.71 (br, 1H, D₂O exchangeable, OH), 4.71 (d, *J* = 7 Hz, 1H), 5.82 (d, *J* = 7 Hz, 1H), 6.91 (d, *J* = 8.5 Hz, 2H), 6.96 (t, *J* = 7.5 Hz, 1H), 7.12-7.13 (m, 3H), 7.37 (d, *J* = 8.5 Hz, 2H), 7.51 (dd, *J* = 2, 8.5 Hz, 2H), 7.67 (m, 1H), 7.87 (d, *J* = 8.5 Hz, 2H), 8.19 (br, 1H, D₂O exchangeable, NH). ¹³C NMR (CDCl₃, 125 MHz, ppm): δ 46.6, 75.8, 111.2, 111.1, 118.7, 119.3, 119.6, 112.3, 123.1, 126.6, 128.1, 129.5, 130.0, 130.5, 132.3, 133.0, 136.2, 140.7, 199.1. IR (KBr) ν : 3420 (NH), 3376 (OH) 3133, 2917, 1679 (C=O), 1584, 1400, 1099, 1063, 742 cm⁻¹. HR-MS (*m/z*) for C₂₃H₁₇Cl₂NNaO₂ (M+Na⁺) Anal. calcd. 432.0528; found 432.0526.

1-(4-chlorophenyl)-2-hydroxy-3-(1H-indol-3-yl)-3-(3-nitrophenyl)propan-1-one (3g):

Yield: 92%; yellow semi solid; ¹H NMR (CDCl₃, 500 MHz, ppm): δ 3.80 (1H, D₂O-exchangeable, OH), 4.79 (d, *J* = 7Hz, 1H), 5.90

(d, $J = 7$ Hz, 1H), 7.02 (t, $J = 7.5$ Hz, 2H), 7.18 (t, $J = 8$ Hz, 2H), 7.34-7.38 (m, 5H), 7.45 (t, $J = 8$ Hz, 2H), 7.69 (d, $J = 7.5$ Hz, 1H), 8.01 (br, 1H, D₂O-exchangeable, NH), 8.21 (s, 1H). ¹³C NMR (CDCl₃, 125 MHz, ppm): δ 48.0, 76.2, 101.0, 107.5, 111.1, 116.9, 119.0, 122.3, 123.4, 126.8, 127.8, 127.9, 128.7, 129.3, 130.3, 132.3, 134.2, 136.1, 137.9, 139.8, 148.3. IR (KBr) ν : 3407 (OH and NH), 3141, 2921, 2847, 1677 (C=O), 1590, 1527, 1400, 1348, 1093, 738 cm⁻¹. HR-MS(m/z) for C₂₃H₁₇ClN₂NaO₄ calcd. 443.0769; found 443.0765.

1-(4-chlorophenyl)-2-hydroxy-3-(1H-indol-3-yl)-3-p-tolylpropan-1-one (3h):

Yield: 89%; yellow semi solid; mp: 123-125 °C; ¹H NMR (CDCl₃, 500 MHz, ppm): δ 2.22 (s, 3H), 3.67 (br, 1H, D₂O-exchangeable, OH), 4.68 (d, $J = 7.5$ Hz, 1H), 5.76 (dd, $J = 1.5, 7.5$ Hz, 1H), 6.85 (d, $J = 8$ Hz, 2H), 6.94 (d, 8 Hz, 3H), 7.09-7.12 (m, 1H), 7.17 (d, $J = 7.5$ Hz, 1H), 7.26 (d, $J = 8$ Hz, 1H), 7.43 (d, $J = 8.5$ Hz, 2H), 7.57 (s, 1H), 7.81 (d, $J = 8.5$ Hz, 2H), 8.15 (br, 1H, D₂O-exchangeable, NH). ¹³C NMR (CDCl₃, 125 MHz, ppm): δ 21.1, 46.8, 76.2, 111.2, 116.6, 118.8, 119.5, 122.1, 123.1, 124.5, 126.9, 128.8, 129.1, 129.4, 130.1, 132.6, 134.5, 136.7, 140.5, 199.5. IR (KBr) ν : 3446 (OH), 3389(NH), 3050, 2920, 1680 (C=O), 1589, 1455, 1399, 1262, 1093, 991, 742 cm⁻¹. HR-MS(m/z) for C₂₄H₂₀ClNNaO₂ (M+Na⁺) Anal. calcd. 412.1074; found 412.1070.

3-(4-chlorophenyl)-2-hydroxy-3-(1H-indol-3-yl)-1-p-tolylpropan-1-one (3i):

Yield: 94%; yellow semi solid; ¹H NMR (CDCl₃, 500 MHz, ppm): δ 2.22 (s, 3H), 3.62 (br, 1H, D₂O-exchangeable, OH), 4.62 (d, $J = 7.6$ Hz, 1H), 5.80 (dd, $J = 7.6, 2.5$ Hz, 1H), 6.80 (d, $J = 7.5$ Hz, 2H), 6.91-6.94 (m, 3H), 7.14 (t, $J = 7.5$ Hz, 2H), 7.20 (d, $J = 8$ Hz, 1H), 7.35 (d, $J = 8$ Hz, 1H), 7.66-7.69 (m, 2H), 7.78 (dd, $J = 1.5, 6.5$ Hz, 2H), 8.17 (br, 1H, D₂O-exchangeable, NH). ¹³C NMR (CDCl₃, 125 MHz, ppm): δ 21.1, 46.7, 76.8, 112.1, 116.6, 119.0, 119.5, 122.8, 123.4, 126.2, 129.0,

129.1, 129.4, 130.1, 132.3, 134.5, 136.0, 136.7, 139.6, 200.1. IR (KBr) ν : 3410 (OH and NH), 3130, 2924, 1678 (C=O), 1581, 1400, 1262 cm^{-1} . HR-MS(m/z) for $\text{C}_{24}\text{H}_{20}\text{ClNNaO}_2$ ($\text{M}+\text{Na}^+$) Anal. calcd. 412.1074; found 412.1071.

3-(4-chlorophenyl)-1-(4-fluorophenyl)-2-hydroxy-3-(1H-indol-3-yl)propan-1-one (3j):

Yield: 90%; yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm): δ 3.76 (br, 1H, D_2O -exchangeable, OH), 4.69 (d, $J = 7$ Hz, 1H), 5.79 (d, $J = 7$ Hz, 1H), 6.89 (d, $J = 2$ Hz, 2H), 6.95 (t, $J = 7$ Hz, 1H), 7.09-7.18 (m, 6H), 7.29 (d, $J = 3$ Hz, 1H), 7.61 (m, 1H), 7.91-7.93 (m,

2H), 8.23 (br, 1H, D_2O -exchangeable, NH). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 46.5, 75.6, 111.2, 116.0, 116.2, 116.4, 118.6, 119.5, 122.2, 123.0, 126.5, 128.0, 130.4, 131.3, 132.8, 135.9, 136.1, 167.2, 198.6. IR (KBr) ν : 3415 (OH and NH), 3124, 2924, 1679 (C=O), 1597, 1457, 1238, 1093, 842, 744 cm^{-1} . HR-MS(m/z) for $\text{C}_{23}\text{H}_{17}\text{ClFNNaO}_2$ ($\text{M}+\text{Na}^+$) Anal. calcd. 416.0824; found 416.0826.

1-(4-bromophenyl)-2-hydroxy-3-(1H-indol-3-yl)-3-phenylpropan-1-one (3k):

Yield: 94%; yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm): δ 3.65 (br, 1H, D_2O exchangeable, OH), 4.73 (d, $J = 7.5$ Hz, 1H), 5.81 (d, $J = 7.5$ Hz, 1H), 6.97-7.02 (m, 2H), 7.15-7.18 (m, 4H), 7.36 (d, J

= 8 Hz, 2H), 7.66-7.69 (m, 3H), 7.79 (d, $J = 8$ Hz, 2H), 8.16 (br, 1H, D_2O exchangeable, NH). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 46.1, 75.1, 98.9, 110.0, 115.5, 117.8, 118.5, 121.1, 122.0, 125.8, 126.1, 126.9, 128.1, 129.0, 131.4, 131.9, 134.9, 136.5, 198.4. IR (KBr) ν : 3416 (NH), 3363 (OH), 3134, 2962, 2923, 2847, 1680 (C=O), 1585, 1400, 1261, 1098, 1022, 803 cm^{-1} . HR-MS (m/z) for $\text{C}_{23}\text{H}_{18}\text{BrNNaO}_2$ ($\text{M}+\text{Na}^+$) Anal. calcd. 442.0413; found 442.0419.

1-(4-bromophenyl)-2-hydroxy-3-(1H-indol-3-yl)-3-p-tolylpropan-1-one (3l):

Yield: 88%; yellow solid; mp: 137-139 °C; ¹H NMR (CDCl₃, 500 MHz, ppm): δ 2.25 (s, 3H), 3.61 (br, 1H, D₂O-exchangeable, OH), 4.70 (d, *J* = 7.5 Hz, 1H), 5.79 (d, *J* = 7.5 Hz, 1H), 6.86 (dd, *J* = 8, 1.5 Hz, 2H), 6.95 (d, *J* = 4.5 Hz, 2H), 7.14 (t, *J* = 7.5 Hz, 2H), 7.18 (d, *J* = 8.5 Hz, 1H), 7.35 (d, *J* = 8 Hz, 1H), 7.65-7.67 (m, 2H), 7.78-7.84 (m, 3H), 8.14 (br, 1H, D₂O-exchangeable, NH). ¹³C NMR (CDCl₃, 125 MHz, ppm): δ 21.0, 46.7, 76.2, 111.0, 116.7, 118.7, 119.4, 122.1, 122.9, 126.8, 128.7, 129.9, 130.0, 132.3, 133.0, 134.4, 135.9, 136.6, 199.5. IR (KBr) ν: 3456 (OH), 3392 (NH), 3133, 2917, 1679 (C=O), 1584, 1400, 1099, 1063, 742 cm⁻¹. HR-MS(*m/z*) for C₂₄H₂₀BrNNaO₂ (M+Na⁺) Anal. calcd. 456.0569; found 456.0561.

1-p-tolyl-2-hydroxy-3-(1H-indol-3-yl)-3-(4-bromophenyl)-propan-1-one (3m):

Yield: 92%; yellow semi solid; ¹H NMR (CDCl₃, 500 MHz, ppm): δ 2.24 (s, 3H), 3.63 (br, 1H, D₂O-exchangeable, OH), 4.69 (d, *J* = 7.5 Hz, 1H), 5.78 (dd, *J* = 7.5, 2 Hz, 1H), 6.85 (d, *J* = 8 Hz, 2H), 6.94-6.96 (m, 2H), 7.13 (t, *J* = 8 Hz, 2H), 7.17 (d, *J* = 7.5 Hz, 1H), 7.33 (d, *J* = 8 Hz, 1H), 7.64-7.66 (m, 3H), 7.78 (dd, *J* = 1.5, 6.5 Hz, 2H), 8.15 (br, 1H, D₂O-exchangeable, NH). ¹³C NMR (CDCl₃, 125 MHz, ppm): δ 21.1, 46.8, 76.2, 111.2, 116.6, 118.9, 119.5, 122.1, 123.1, 126.9, 128.8, 129.1, 129.4, 130.1, 132.6, 134.5, 136.0, 136.7, 140.5, 199.5. IR (KBr) ν: 3416 (OH and NH), 3133, 2922, 1680 (C=O), 1584, 1399, 1262, 1100, 990, 745 cm⁻¹. HR-MS (*m/z*) for C₂₄H₂₀BrNNaO₂ (M+Na⁺) Anal. calcd. 456.0569; found 456.0562.

3-(4-chlorophenyl)-2-hydroxy-3-(1H-indol-3-yl)-1-phenylpropan-1-one (3n):

Yield: 95%; yellow solid; mp: 94-96 °C; ¹H NMR (CDCl₃, 500 MHz, ppm): δ 3.80 (br, 1H, D₂O-exchangeable, OH), 4.74 (d, *J* = 7 Hz, 1H),

5.85 (d, $J = 7$ Hz, 1H), 6.88 (dd, $J = 2, 8.5$ Hz, 2H), 6.93 (td, $J = 1, 7$ Hz, 1H), 7.08-7.14 (m, 4H), 7.29 (d, $J = 8.5$ Hz, 1H), 7.49 (t, $J = 7.5$ Hz, 2H), 7.62-7.65 (m, 2H), 7.90 (dd, $J = 1, 3.5$ Hz, 2H), 8.22 (br, 1H, D₂O-exchangeable, NH). ¹³C NMR (CDCl₃, 125 MHz, ppm): δ 46.5, 75.9, 111.3, 116.3, 118.8, 119.5, 122.3, 123.2, 126.7, 128.1, 128.7, 129.2, 130.6, 132.9, 134.0, 134.2, 136.1, 136.4, 200.3. IR (KBr) ν : 3419 (NH), 3353 (OH), 3050, 2900, 1672 (C=O), 1488, 1403, 1264, 1090, 982, 778, 740, 690. HR-MS(m/z) for C₂₃H₁₈ClNNaO₂ ($M+Na^+$) Anal. calcd. 398.0918; found 398.0916.

3-(4-bromophenyl)-2-hydroxy-3-(1H-indol-3-yl)-1-(4-methoxyphenyl)propan-1-one (3o):

(3o):

Yield: 94%; yellow semi solid; ¹H NMR (CDCl₃, 500 MHz, ppm): δ 3.68 (br, 1H, D₂O-exchangeable, OH), 3.89 (s, 3H), 4.66 (d, $J = 7.6$ Hz, 1H), 5.88 (dd, $J = 2.5, 7.6$ Hz, 1H), 6.85 (d, $J = 7.5$ Hz, 2H), 7.14 (t, $J = 7.5$ Hz, 2H), 7.20 (d, $J = 8$ Hz, 1H), 7.35 (d, $J = 8$

Hz, 1H), 7.66-7.71 (m, 3H), 7.78 (dd, $J = 1.5, 6.5$ Hz, 2H), 7.80 (d, $J = 7.5$ Hz, 2H), 8.17 (br, 1H, D₂O-exchangeable, NH). ¹³C NMR (CDCl₃, 125 MHz, ppm): δ 46.7, 55.4, 76.8, 112.1, 116.6, 119.0, 119.5, 122.8, 123.4, 126.2, 129.0, 129.1, 129.4, 130.1, 132.3, 134.5, 136.0, 136.7, 139.6, 200.1. IR (KBr) ν : 3410(OH and NH), 1678 (C=O), 1554, 1412, 1256 cm⁻¹. HR-MS(m/z) for C₂₄H₂₀BrNNaO₃ ($M+Na^+$) Anal. calcd. 472.0518; found 472.0515.

2-hydroxy-3-(1H-indol-3-yl)-1-(naphthalen-2-yl)-3-phenylpropan-1-one (3p):

Yield: 95%; yellow solid; mp: 122-124 °C; ¹H NMR (CDCl₃, 500 MHz, ppm): δ 3.82 (br, 1H, D₂O-exchangeable, OH), 4.88 (d, $J = 7.5$ Hz, 1H), 6.02 (dd, $J = 2, 7.5$ Hz, 1H), 6.92 (t, $J = 7.5$ Hz, 1H),

6.98 (d, $J = 6.5$ Hz, 2H), 7.11-7.16 (m, 5H), 7.33 (d, $J = 8$ Hz, 1H), 7.57 (t, $J = 7$ Hz, 1H), 7.64 (t, $J = 7$ Hz, 1H), 7.34 (s, 1H), 7.91-7.95 (m, 4H), 8.21 (br, 1H, D₂O-exchangeable, NH), 8.47 (s, 1H). ¹³C NMR (CDCl₃, 125 MHz, ppm): δ 47.4, 76.24, 111.1, 116.8, 119.4, 122.1,

123.2, 124.1, 127.0, 127.1, 127.9, 129.1, 129.1, 129.3, 129.8, 130.4, 131.5, 132.5, 136.0, 136.0, 137.8, 140.2, 200.4. IR (KBr) ν : 3442 (OH and NH), 3133, 3058, 2922, 1670 (C=O), 1402, 1277, 1093, 749 cm^{-1} . HR-MS (m/z) for $\text{C}_{27}\text{H}_{21}\text{NNaO}_2$ ($\text{M}+\text{Na}^+$) Anal. calcd. 414.1464; found 414.1462.

2-hydroxy-3-(1H-indol-3-yl)-1-(naphthalen-2-yl)-3-p-tolylpropan-1-one (3q):

Yield: 88%; yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm):

δ 2.14 (s, 3H), 3.73 (br, 1H, D_2O -exchangeable, OH), 4.76 (d, $J = 7.5$ Hz, 1H), 5.90 (dd, $J = 1.6, 7.5$ Hz, 1H), 6.77-6.85 (m, 5H), 7.01 (t, $J = 8$ Hz, 1H), 7.07 (d, $J = 8$ Hz, 1H), 7.20 (d, $J = 8$ Hz, 1H), 7.45

(t, $J = 7$ Hz, 1H), 7.53 (t, $J = 7$ Hz, 1H), 7.60 (s, 1H), 7.79-7.85 (m, 4H), 8.13 (br, 1H, D_2O -exchangeable, OH), 8.36 (s, 1H). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 21.1, 47.0, 76.3, 111.2, 116.9, 119.1, 119.4, 122.1, 123.1, 124.2, 127.0, 127.1, 127.9, 128.7, 129.1, 129.1, 129.2, 129.8, 130.4, 131.6, 132.5, 134.7, 136.0, 136.1, 136.5, 200.5. IR (KBr) ν : 3500 (OH), 3406 (NH), 3051, 2920, 1674 (C=O), 1456, 1412, 1277, 1096, 749 cm^{-1} . HR-MS (m/z) for $\text{C}_{28}\text{H}_{23}\text{NNaO}_2$ ($\text{M}+\text{Na}^+$) Anal. calcd. 428.1620; found 428.1622.

2-hydroxy-3-(1H-indol-3-yl)-3-(4-methoxyphenyl)-1-(naphthalene-2-yl)propan-1-one (3r) :

Yield: 85%; yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm):

δ 3.67 (s, 3H), 4.12 (br, 1H, D_2O -exchangeable, OH), 4.69 (d, $J = 7$ Hz, 1H), 5.89 (dd, $J = 1.5, 7$ Hz, 1H), 6.77 (dd, $J = 2, 6.6$ Hz, 2H), 6.95 (t, $J = 8$ Hz, 1H), 7.01-7.04 (m, 2H), 7.05-7.11 (m, 1H), 7.16-

7.18 (m, 1H), 7.30-7.38 (m, 3H), 7.51 (t, $J = 8$ Hz, 1H), 7.57 (t, $J = 5.5$ Hz, 2H), 7.77-7.82 (m, 2H), 8.12-8.22 (m, 2H). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 48.2, 55.3, 76.1, 102.0, 110.8, 114.1, 119.5, 120.2, 121.5, 124.0, 127.2, 127.7, 127.9, 129.0, 129.1, 129.4, 129.7, 130.3, 131.3, 131.8, 132.3, 135.9, 136.0, 136.3, 200.3. IR (KBr) ν : 3412 (OH and NH), 3129,

2924, 2854, 1675 (C=O), 1510, 1457, 1403, 1250, 1179, 1029, 744 cm^{-1} . HR-MS (m/z) for $\text{C}_{28}\text{H}_{23}\text{NNaO}_3$ ($M+\text{Na}^+$) Anal. calcd. 444.1570; found 444.1569.

3-(4-chlorophenyl)-2-hydroxy-1-(naphthalen-2-yl)-3-(1H-pyrrol-2-yl)propan-1-one (3s):

Yield: 72%; light yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm):

δ 3.79 (br, 1H, D_2O -exchangeable, OH), 4.79 (d, $J = 7.5$ Hz, 1H), 5.87 (dd, $J = 1.5, 7.5$ Hz, 1H), 6.02 (dd, $J = 3.6, 5.4$ Hz, 1H), 6.13 (dd, $J = 2.5, 5.4$ Hz, 1H), 6.4-6.54 (m, 1H), 6.71 (dd, $J = 2.5, 3.6$ Hz, 1H), 6.77

(dd, $J = 2, 6.6$ Hz, 2H), 6.95 (t, $J = 8$ Hz, 1H), 7.01-7.04 (m, 2H), 7.05-7.11 (m, 1H), 7.16-7.18 (m, 1H), 7.30-7.38 (m, 2H), 7.51 (t, $J = 8$ Hz, 1H), 8.19 (br, 1H, D_2O -exchangeable, NH). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 47.1, 76.1, 100.8, 106.0, 108.4, 116.8, 118.0, 112.1, 123.1, 126.9, 127.9, 128.7, 129.3, 131.9, 132.1, 134.0, 136.0, 137.7, 165.3, 200.4. IR (KBr) ν : 3412 (OH and NH), 3124, 2923, 1680 (C=O), 1626, 1452, 1258, 1106, 744, 697 cm^{-1} . HR-MS (m/z) for $\text{C}_{23}\text{H}_{18}\text{ClNNaO}_2$ Calcd. 398.0918; found 398.0917.

3-(4-chlorophenyl)-2-hydroxy-3-(1H-indol-3-yl)-1-(naphthalen-2-yl)propan-1-one (3t):

Yield: 91%; yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm): δ

3.85 (br, 1H, D_2O -exchangeable, OH), 4.85 (d, 7.5 Hz, 1H), 6.02 (dd, $J = 1.5, 7.5$ Hz, 1H), 6.89-6.95 (m, 3H), 7.10-7.16 (m, 4H), 7.37

(d, $J = 9.5$ Hz, 1H), 7.59 (t, $J = 7$ Hz, 1H), 7.67 (t, $J = 7.5$ Hz, 1H), 7.75 (s, 1H), 7.93-7.99 (m, 5H), 8.22 (br, 1H, D_2O -exchangeable, NH). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 46.8, 75.9, 111.2, 116.4, 118.9, 119.6, 122.3, 123.2, 124.0, 126.7, 127.3, 127.9, 128.1, 129.2, 129.2, 129.8, 130.5, 130.6, 131.2, 132.5, 132.9, 136.0, 136.0, 136.4, 200.2. IR (KBr) ν : 3411 (OH and NH), 3055, 2920, 1673 (C=O), 1486, 1408, 1272, 1093, 1015, 742 cm^{-1} . HR-MS (m/z) for $\text{C}_{27}\text{H}_{20}\text{ClNNaO}_2$ ($M+\text{Na}^+$) Anal. calcd. 448.1074; found 448.1075.

3-(4-chlorophenyl)-2-hydroxy-3-(2-methyl-1H-indol-3-yl)-1-(naphthalen-2-yl)propan-1-one (3u):

Yield: 86%; yellow semi solid; ^1H NMR (CDCl_3 , 500 MHz, ppm): δ 2.17 (s, 3H), 3.72 (br, 1H, D_2O -exchangeable, OH), 4.60 (d, $J = 7$ Hz, 1H), 6.02 (d, $J = 7$ Hz, 1H), 6.89-6.95 (m, 3H), 7.12-7.19 (m, 3H), 7.33 (d, $J = 9.5$ Hz, 1H), 7.51 (t, $J = 7$ Hz, 1H), 7.67 (t, $J = 7.5$ Hz, 1H), 7.79 (s, 1H), 7.96-8.03 (m, 5H), 8.21 (br, 1H, D_2O -exchangeable, NH). ^{13}C NMR (CDCl_3 , 125 MHz, ppm): δ 11.9, 47.1, 73.5, 99.9, 110.2, 111.2, 119.1, 119.5, 119.8, 120.7, 121.3, 123.2, 126.6, 127.5, 128.1, 128.7, 129.6, 130.4, 131.1, 131.8, 131.9, 132.1, 135.2, 135.5, 138.6, 202.1. IR (KBr) ν : 3522 (OH), 3421 (NH), 3075, 2931, 1686 (C=O), 1492, 1434, 1299, 1093, 1017 cm^{-1} . 1 . HR-MS (m/z) for $\text{C}_{28}\text{H}_{22}\text{ClNNaO}_2$ ($\text{M}+\text{Na}^+$) Anal. calcd. 462.1231; found. 462.1230.

4. References

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5. ^1H and ^{13}C NMR spectra