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# **Supporting Information**

### **Optically pure 2-(quinolin-8-yloxy)cyclohexan-1-ol as a practical agent** for molecular recognition by NMR and fluorescence spectroscopy

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### **General Information**

Reagents were purchased from Sigma-Aldrich Chemicals Limited, SD Fine, Sisco, Qualigens, Avara Chemicals Limited etc. All solvents that were used were stored on oven dried molecular sieves (4Å). All commercial products were used without further purification. Toluene was distilled and dried by passing Sodium wire. Thin Layer Chromatography was performed on Merck 60 F254 Aluminium coated plates. The spots were visualized under UV light or with iodine vapour. All the compounds were purified by column chromatography using SRL silica gel (60-120 mesh). All reactions were carried out under an inert atmosphere (nitrogen) unless other conditions are specified. <sup>1</sup>H, <sup>13</sup>C and <sup>31</sup>P NMR spectra are recorded on a 400 MHz Bruker Avance 400 Spectrometer (100 MHz for <sup>13</sup>C and 162 MHz for <sup>31</sup>P respectively) spectrometer with CDCl<sub>3</sub> as solvent and TMS as internal standard. Signal multiplicity is denoted as singlet (s), doublet (d), doublet of doublets (ddd), triplet (t), doublet of triplet (dt), quartet (q) and multiplet (m). Mass spectra were recorded on Thermo-Fischer DSQ II GCMS instrument. IR spectra were recorded on a Perkin-Elmer FTIR RXI spectrometer as KBr pallets or neat in case of liquids. UVvis spectra were recorded on Perkin-Elmer  $\lambda$ -35. Fluorescence spectra were recorded on Jasco FP-6300 Spectrofluorometer. All <sup>1</sup>H, <sup>19</sup>F and <sup>31</sup>P CSA NMRs were recorded by mixing lequiv (20 mmol) of (R,R)-1 and 1 equiv (20mmol) of hosts (A-F) in 0.6ml CDCl<sub>3</sub>.

### **Experimental Procedure**

Synthesis of 2-(quinolin-8-yloxy)cyclohexan-1-ol (1)



In a solution containing potassium hydroxide (0.386 g, 6.89 mmol) in water (16mL) in two neck round bottom flask, was added 8-hydroxy quinoline (1.0 g, 6.89 mmol) and heated at 100 °C. To this solution, cyclohexene oxide (0.81 g, (0.81 mL) 8.2 mmol) was added after 30 mins. The reaction was allowed to reflux for 18 h. The mixture was then and extracted with ethyl acetate 3 x 50 mL. The combined extracts were then dried over sodium sulphate and evaporated under vacuum. The crude reaction mixture was then subjected to column chromatography on silica gel. The desired alcohol was eluted with 50 % ethyl acetate/ petroleum ether. (1.43 g, 86%).<sup>1</sup> M.p = 106 °C.

<sup>1</sup>**H** NMR (CDCl<sub>3</sub>, 400MHz): δ ppm 8.89-8.87 (dd, J = 8.0, 1.6 Hz, 1H), 8.21-8.19 (dd, J = 7.6, 1.6 Hz, 1H), 7.57-7.55 (dd, J = 8.0, 1.2 Hz, 1H), 7.50-7.48 (d, J = 7.6 Hz, 1H), 7.47-7.43 (m, 2H), 7.36-7.34 (dd, J = 7.6, 1.6 Hz, 1H), 6.94 (s, broad 1H –OH), 3.98-3.92 (m, 1H), 3.89-3.83 (m, 1H), 2.34-2.33 (m, 1H), 2.19-2.16 (m, 1H), 1.80-1.72 (m, 2H), 1.67-1.64 (m, 1H), 1.37-1.26 (m, 3H).

<sup>13</sup>C NMR (CDCl<sub>3</sub>, 100MHz): δ ppm 154.2, 149.0, 141.6, 136.9, 129.9, 126.9, 122.6, 121.6, 118.7, 88.6, 73.4, 33.2, 31.0, 24.5, 23.9.

**IR** (KBr)  $\nu$  cm<sup>-1</sup>: 3352, 3045, 2934, 1617, 1468, 1380, 1106, 1081, 735.

Mass (ESI): m/z 244 M (100%), 242.1, 225.1, 146.1.

HRMS (ESI): calcd for C<sub>15</sub>H<sub>18</sub>NO<sub>2</sub> (M+1) 244.1335 found 244.1338.

Enzymatic resolution of 2-(quinolin-8-yloxy)cyclohexan-1-ol (1)

To a solution of racemic alcohol (1) (0.30 g, 1.2 mmol) in dry THF (5 mL), lipase (0.9 g, 300% w/w, Steapsin) and vinyl acetate (0.57 mL, 6.1 mmol) were added and the reaction mixture was stirred for 6d at 30 °C. The material was filtered and the filtrate was concentrated under vacuum. The crude mixture was separated by column chromatography on silica gel using ethyl acetate/ petroleum ether as eluent. The acetate (R,R)-4 was eluted with 30% ethyl acetate. (0.13 g, 37%).



 $[\alpha]_D^{25} = (-23.16) (c = 1, CHCl_3)$ 

<sup>1</sup>**H NMR** (CDCl<sub>3</sub>, 400MHz):  $\delta$  ppm 8.91-8.07 (m, 1H), 8.09-8.07 (d, J = 8.4 Hz, 1H), 7.45-7.40 (m, 1H), 7.39-7.35 (m, 2H), 7.27-7.25 (d, J = 7.2 Hz, 1H), 5.22-5.07 (m, -CHOAc, 1H), 4.60-4.55 (m, -CHOAr,1H), 2.70-2.35 (m, 1H), 2.16-2.13 (m, 1H), 1.85-1.82 (m, 2H), 1.79-1.72 (m, 4H, -COCH<sub>3</sub> included), 1.46-1.35 (m, 3H).

<sup>13</sup>C NMR (CDCl<sub>3</sub>, 100MHz): δ ppm 170.3, 154.6, 149.3, 141.1, 135.8, 129.6, 126.5, 121.4, 120.3, 112.5, 79.4, 74.8, 30.1, 29.9, 23.4, 23.1, 21.1.

**IR** (KBr) v cm<sup>-1</sup>: 3039, 2940, 1736, 1639, 1596, 1468, 1373, 1102, 1038, 731.

Mass (ESI): m/z 309 M+Na (100%).

HRMS (ESI): calcd for C<sub>17</sub>H<sub>20</sub>NO<sub>2</sub> (M+1) 286.1443 found 286.1456.

HPLC condition: Lux Amylose column, 30% iso-propanol in hexane, flow rate 1.0 mL/min, UV 254 nm, retention time 18.5 min for (S,S)-isomer, 21.5 min for (R,R)-isomer.



The unreacted alcohol was eluted with 50 % ethyl acetate in petroleum ether. (0.16 g, 53%)  $[\alpha]_{D}^{25} = (160.5) (c = 1, CHCl_{3})$ 

HPLC condition: Chiralcel OD-H column, 30% iso-propanol in hexane, flow rate 1.0 mL/min, UV 254 nm, retention time 4.94 min for (R,R)-isomer, 7.74 min for (S,S)-isomer.

Determination of Absolute Configuration: Synthesis of (R, R, R)-5



ORTEP diagram of the compound (R, R, R)-5 (50% probability factor for thermal ellipsoids) CCDC-1853111

Alcohol (*R*,*R*)-1 (0.10 g, 4.1 mmol), DCC (0.084 g, 4.1 mmol) and DMAP (0.010 g 0.8 mmol) were placed in two-necked flask under nitrogen atmosphere, were dissolved in dry dichloromethane (10 mL) and cooled to 0 °C. A solution of (R)-O-acyl mandelic acid (0.079 g, 4.1 mmol) in dichloromethane (5 mL) was then added drop wise. The reaction mixture was stirred at rt for 4h.athe reaction mixture was then filtered through Celite bed, washed with dichloromethane and purified by column chromatography over silica gel (30% ethyl acetate/petroleum ether) affording white solid (0.13 g, 76%)

M.p = 92 °C.  $[\alpha]_{D}^{25} = -118.9 (c = 1, CHCl_3)$ 

<sup>1</sup>**H** NMR (CDCl<sub>3</sub>, 400MHz):  $\delta$  ppm 8.88-8.87 (dd, J = 4.0, 1.2 Hz, 1H), 8.11-8.09 (dd, J = 8.0, 2.4 Hz, 1H), 7.42-7.40 (dd, J = 8.4, 3.2, 1H), 7.36-7.33 (dd, J = 8.4, 4.0 Hz, 2H), 7.20-7.18 (m, 2H), 7.03-7.00 (m, 1H), 6.92-6.89 (m, 1H), 6.81-6.78 (t, J = 7.6 Hz, 2H), 5.85 (s, -CHOAc, 1H), 5.31-5.27 (m, -CHOCO, 1H), 4.52-4.48 (m, -CHOAr, 1H), 2.27-2.26 (m, 1H), 2.13 (s, 3H), 2.09-2.01 (m, 1H), 1.87-1.81 (m, 1H), 1.79-1.74 (m, 2H), 1.57-1.27 (m, 4H).

<sup>13</sup>**C NMR** (CDCl<sub>3</sub>, 100MHz): δ ppm 170.4, 168.1, 153.8, 149.0, 140.7, 135.7, 133.3, 129.6, 128.5, 128.0, 127.3, 126.5, 121.4, 119.7, 110.3, 75.5, 74.5, 29.6, 29.4, 23.1, 23.0, 20.7.

**IR** (KBr) v cm<sup>-1</sup>: 3046, 2939, 1759, 1738, 1564, 1464, 1372, 1104, 1053, 758.

Mass (ESI): m/z 443.1 (M+Na) (100%).

HRMS (ESI): calcd for C<sub>25</sub>H<sub>26</sub>NO<sub>5</sub> (M+1) 420.1811 found 420.1807.

Spectral Data



Figure 1: <sup>1</sup>H NMR Spectra of **1** 



Figure 2: <sup>13</sup>C NMR Spectra of **1** 



Figure 3: IR Spectra of 1



Figure 4: MS Spectra of 1



Figure 5: HRMS Spectra of 1



Figure 6: HPLC Chromatogram of a) *rac*-1, b) (*S*,*S*)-1 before crystallization (60 %*ee*), c) (*S*,*S*)-1 after crystallization and d) (*R*,*R*)-1 after hydrolysis.

Chiralcel-OD-H column: 30% Isopropyl alcohol-Hexane, UV=254 nm, Flow= 1.0mL/min.

 $R_t = 4.9 \min (1^{st} Peak)$  and  $R_t = 7.7 \min (2^{nd} Peak)$ 



Figure 7: <sup>1</sup>H NMR Spectra of **4** 



Figure 8: <sup>13</sup>C NMR Spectra of 4



Figure 9: IR Spectra of 4



Figure 10: MS Spectra of 4



Figure 11: HRMS Spectra of 4



Figure 12: HPLC Chromatogram of a) rac-4 and b) (R,R)-4

Lux Amylose column: 30% Isopropyl alcohol-Hexane, UV=254 nm, Flow= 1.0 mL/min.

 $R_t = 18.5 \min (1^{st} \text{ Peak}) \text{ and } R_t = 21.5 \min (2^{nd} \text{ Peak})$ 



Figure 13: <sup>1</sup>H NMR Spectra of **5** 



Figure 14: <sup>13</sup>C NMR Spectra of **5** 



Figure 15: IR Spectra of 3



Figure 16: MS Spectra of 5



Figure 17: HRMS Spectra of 5

CSA Spectras



Figure 18: <sup>1</sup>H NMR Spectra of Mandelic acid (A-I) with (R,R)-1



Figure 19: <sup>1</sup>H NMR Spectra of 4-trifluoromethyl-mandelic acid (A-II) with (R,R)-1



Figure 20: <sup>19</sup>F NMR Spectra of 4-trifluoromethyl-mandelic acid (A-II) with (R,R)-1



Figure 21: <sup>1</sup>H NMR Spectra of 2-chloro-mandelic acid (A-III) with (R,R)-1



Figure 22: <sup>1</sup>H NMR Spectra of 3,4-methylene-dioxo-mandelic acid (A-IV) with (R,R)-1



Figure 23: <sup>1</sup>H NMR Spectra of 4-bromo-mandelic acid (A-V) with (R,R)-1



Figure 24: IR Spectra of salt of (R,R)-1-(R)-MA



Figure 25: Job's Plot with (S)-mandelic acid



Figure 26: Selected region of <sup>1</sup>H NMR spectra of scalemic mixture of A-I in presence of (R,R)-1 (Left) and its correlation between theoretical and observed % *ee* values (Right).



Figure 27: Selected region of <sup>1</sup>H NMR spectra of varying ratio of concentration of (*R*,*R*)-1 with racemic **A-I.** The value in parenthesis indicates  $\Delta\Delta\delta$  in Hz.



Figure 28: Selected region of <sup>1</sup>H NMR spectra of (*R*,*R*)-1 with racemic **A-I** with increasing concentration of CSA-analyte. The value in parenthesis indicates  $\Delta\Delta\delta$  in Hz.



Figure 29: Selected region of <sup>1</sup>H NMR spectra of (R,R)-1 with racemic A-I in different solvents.



Figure 30: <sup>1</sup>H NMR Spectra of 2-bromo-2-phenylacetic acid (**B-I**) with (*R*,*R*)-1



Figure 31: <sup>1</sup>H NMR Spectra of 2-chloro-2-phenylacetic acid (**B-II**) with (R, R)-1



Figure 32: <sup>1</sup>H NMR Spectra of 2-chloro-2-(2chlorophenyl) acetic acid (**B-III**) with(*R*,*R*)-1



Figure 33: <sup>1</sup>H NMR Spectra of 2-chloro-2-(4-trifluoromethyl-phenyl) acetic acid (**B-IV**) with (R,R)-1



Figure 34: <sup>19</sup>F NMR Spectra of 2-chloro-2-(4-trifluoromethyl-phenyl) acetic acid (**B-IV**) with (R,R)-1



Figure 35: <sup>1</sup>H NMR Spectra of C with (R,R)-1



Figure 36: <sup>19</sup>F NMR Spectra of C with (R,R)-1



Figure 37: <sup>1</sup>H NMR Spectra of Tetrol (**D-I**) with (R,R)-1



Figure 38: <sup>1</sup>H NMR enlarged Spectra of Tetrol (**D-I**) with (R,R)-1



Figure 39: <sup>1</sup>H NMR Spectra of Dibromo-binol (**D-II**) with (R,R)-1



Figure 40: <sup>1</sup>H NMR enlarged Spectra of Dibromo-binol (**D-II**) with (R,R)-1



Figure 41: <sup>31</sup>P NMR Spectra of Binaphthyl phosphoric acid (E) with (R,R)-1



Figure 42: <sup>1</sup>H NMR Spectra of (**F-I**) with (R,R)-1



Figure 43: <sup>31</sup>P NMR Spectra of (**F-I**) with (R,R)-1



Figure 44: <sup>1</sup>H NMR Spectra of (**F-II**) with (R,R)-1



Figure 45: <sup>31</sup>P NMR Spectra of (**F-I**) with (R,R)-1



Figure 46: <sup>1</sup>H NMR Spectra of (**F-III**) with (R,R)-1



Figure 47: <sup>31</sup>P NMR Spectra of (**F-III**) with (R,R)-1



Figure 48: <sup>1</sup>H NMR Spectra of (**F-IV**) with (R,R)-1

## X-Ray Crystal data

X-ray crystal data for CCDC No 1853115 (*R*,*R*)-1 and CCDC No 1853116 (*S*,*S*)-1

Details	Compound ( <i>R</i> , <i>R</i> )-1	Compound ( <i>S,S</i> )-1
	CCDC-1853115	CCDC-1853116
Empirical Formula	C <sub>15</sub> H <sub>17</sub> NO <sub>2.5</sub>	C <sub>15</sub> H <sub>17</sub> NO <sub>2.5</sub>
Formula Weight	504.61	504.61
Temperature	293(2)	293(2)
Wavelength	0.71073A	0.71073A
Crystal system	Orthorhombic	Orthorhombic
Space group	C 222 <sub>1</sub>	C 222 <sub>1</sub>
Unit cell dimensions	a = 8.4035(9) Å	a = 8.3581(6) Å
	b = 22.609(2) Å	b = 22.439(2) Å
	c = 14.0695(18) Å	c = 14.0407(11) Å
	$\alpha = 90^{\circ}$	$\alpha = 90^{\circ}$
	β = 90°	β = 90°
	$\gamma = 90^{\circ}$	$\gamma = 90^{\circ}$
Volume	2673.1	2633.3 (4)
Z	4	4
(Density calculated)	1.2538	1.268
Absorption coefficient(µ)	0.085	0.086
F(000)	1080.5	1072.0
Crystal size	-	-
2θ range for data collection	6.82 to 57.34°	7.58 to140.06o
Reflections collected	8210	3560
Independent reflections	2971[R(int) = 0.0209]	2607[R(int) = 0.0192]
Refinement method	Least Squares minimisation	Least Squares minimization
Data / restraints /	2971/0/453	2607/0/453
Parameters		
Goodness of fit on F2	1.0419	1.029
Final R indices	R <sub>1</sub> =0.0396, wR <sub>2</sub> = 0.0828	R <sub>1</sub> =0.0421, wR <sub>2</sub> =0.091
[I>2sigma(I)]		
R indices (all data)	$R_1 = 0.0531$ , $wR_2 = 0.0902$	$R_1 = \overline{0.0584}, wR_2 = 0.1011$
Largest difference peak and	0.15/-0.15	0.14/-0.16
hole		

#### Table 1 Bond Lengths for CCDC No 1853115 (R,R)-1

Atom	Atom	Length/Å	Atom	Atom	Length/Å
O11	C12	1.4488(16)	C13	C14	1.526(2)
O11	C3	1.3614(17)	C16	C15	1.512(3)
O18	C17	1.4206(19)	C2	C7	1.424(2)
C12	C17	1.528(2)	C4	C5	1.416(2)
C12	C13	1.511(2)	C15	C14	1.523(3)
C3	C2	1.4358(19)	C6	C5	1.359(2)
C3	C4	1.369(2)	C6	C7	1.414(3)
C17	C16	1.520(2)	C7	C8	1.413(2)
N1	C2	1.360(2)	C9	C10	1.408(3)
N1	C10	1.321(2)	C9	C8	1.354(3)

#### Table 2 Bond Angles for CCDC No 1853115 (R,R)-1

Atom	Atom	Atom	Angle/°	Ato	om	Atom	Atom	Angle/°
C3	O11	C12	119.24(11)	С	7	C2	C3	118.49(14)
C17	C12	O11	106.04(11)	С	7	C2	N1	122.79(13)
C13	C12	O11	111.08(12)	С	5	C4	C3	120.63(15)
C13	C12	C17	111.33(12)	Cl	4	C15	C16	111.47(14)
C2	C3	O11	114.27(12)	Cl	5	C14	C13	110.61(15)
C4	C3	011	125.83(13)	С	7	C6	C5	120.19(15)
C4	C3	C2	119.90(13)	С	6	C5	C4	120.93(16)
C12	C17	O18	111.00(12)	С	6	C7	C2	119.84(15)
C16	C17	O18	108.57(13)	С	8	C7	C2	116.95(16)
C16	C17	C12	109.52(13)	С	8	C7	C6	123.20(16)
C10	N1	C2	117.38(15)	С	8	C9	C10	118.97(17)
C14	C13	C12	110.13(14)	С	9	C10	N1	123.98(19)
C15	C16	C17	112.78(14)	С	9	C8	C7	119.87(17)
N1	C2	C3	118.71(13)					



ORTEP diagram of the compound (R,R)-1 (50% probability factor for thermal ellipsoids) CCDC-1853115

#### Table 3 Bond Lengths for CCDC No 1853116 (S,S)-1

Atom Atom		Length/Å		Atom	Length/Å	
011	C12	1.436(2)	C2	C3	1.360(3)	
011	C2	1.355(2)	C4	C3	1.400(3)	
C1	N10	1.363(3)	C4	C5	1.347(3)	
C1	C6	1.402(3)	O18	C17	1.419(2)	
C1	C2	1.421(3)	C13	C14	1.517(3)	
N10	C9	1.317(3)	C17	C16	1.504(3)	
C12	C13	1.505(3)	C16	C15	1.512(3)	
C12	C17	1.515(3)	C7	C8	1.350(4)	
C6	C5	1.409(3)	С9	C8	1.392(4)	
C6	C7	1.399(3)	C14	C15	1.510(3)	

#### Table 4 Bond Angles for CCDC No 1853116 (S,S)-1

Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°
C2	011	C12	119.43(14)	C5	C4	C3	121.4(2)
N10	C1	C6	122.74(18)	C2	C3	C4	120.4(2)
N10	C1	C2	118.18(17)	C4	C5	C6	119.7(2)
C6	C1	C2	119.07(18)	C12	C13	C14	110.09(18)
C9	N10	C1	117.16(19)	O18	C17	C12	111.30(16)
011	C12	C13	111.20(16)	O18	C17	C16	108.48(16)
011	C12	C17	106.18(14)	C16	C17	C12	109.77(16)
C13	C12	C17	111.69(16)	C17	C16	C15	112.84(18)
C1	C6	C5	119.7(2)	C8	C7	C6	120.1(2)
C7	C6	C1	117.1(2)	N10	C9	C8	123.9(2)
C7	C6	C5	123.1(2)	C15	C14	C13	110.78(19)
011	C2	C1	114.58(16)	C7	C8	C9	118.9(2)
011	C2	C3	125.79(19)	C14	C15	C16	111.53(18)
C3	C2	C1	119.63(19)				



ORTEP diagram of the compound (*S*,*S*)-1 (50% probability factor for thermal ellipsoids) CCDC-1853116



Figure 49: X-ray structure of (R,R)-1 and (S,S)-1 forming helical assembly

The single crystal x-ray analysis of (R,R)-1 exhibits three point interaction with water molecule via intermolecular hydrogen bonds. The crystal structure one molecule of water being shared between two molecules of (R,R)-1 with three hydrogen bonds between  $(N \cdot \cdot \cdot HO)$  (2.063 Å),  $(OH \cdot \cdot O)$  (2.023 Å) and  $(O \cdot \cdot HO)$  (2.981 Å). Additionally the cyclohexyl ring has lateral short interaction with quinoline ring (2.884 Å) constituting a helical assembly with *P*- confirmation. The assembly is formed due to interactions of (R,R)-1 with water as well as intermolecular interactions with other molecule of (R,R)-1. This encouraged us to analyse the crystal of its enantiomer (S,S)-1 which exhibited similar three point interaction between  $(N \cdot \cdot HO)$  (1.966 Å),  $(OH \cdot \cdot O)$  (1.996 Å) and  $(O \cdot \cdot HO)$  (2.969 Å). Moreover it has lateral interaction between cyclohexan ring and quinoline (2.664 Å) resulting in similar helical assembly with opposite *M*-confirmation.

Details	Compound ( <i>R,R,R</i> )-5
	CCDC-1853111
Empirical Formula	$C_{25}H_{26}N_2O_4$
Formula Weight	419.48
Temperature	293(2)
Wavelength	0.71073A
Crystal system	Orthorhombic
Space group	P 2 <sub>1</sub> 2 <sub>1</sub> 2 <sub>1</sub>
Unit cell dimensions	a = 8.1390(5) Å
	b = 15.8253(10) Å
	c = 17.1850(17) Å
	$\alpha$ = 90°
	β = 90°
	γ = 90°
Volume	2213.5(3)
Z	4
(Density calculated)	1.2587
Absorption coefficient(µ)	0.088
F(000)	888.5
Crystal size	-
2θ range for data collection	6.9 to 57.74°
Reflections collected	13669
Independent reflections	5032[R(int) = 0.0419]
Refinement method	Least Squares minimisation
Data / restraints /	5032/0/281
Parameters	
Goodness of fit on F2	0.986
Final R indices	R <sub>1</sub> =0.0546, wR <sub>2</sub> = 0.0830
[I>2sigma(I)]	
R indices (all data)	R <sub>1</sub> = 0.1027, wR <sub>2</sub> = 0.0947
Largest difference peak and	0.280/-0.30
hole	

## X-ray crystal data for CCDC No 1853111 (R,R,R)-5

## Table 7 Bond Lengths for (R,R,R)-5

Atom	Atom	Length/Å	Atom	Atom	Length/Å
011	C3	1.365(2)	C26	C27	1.383(3)
011	C12	1.439(2)	C26	C31	1.374(3)
O21	C20	1.441(2)	C3	C4	1.378(3)
O21	C22	1.360(3)	C4	C5	1.401(3)
O25	C19	1.191(2)	N1	C10	1.311(3)
018	C13	1.454(2)	C27	C28	1.363(3)
018	C19	1.336(2)	C7	C6	1.414(3)
C13	C14	1.518(3)	C7	C8	1.408(3)
C13	C12	1.504(3)	C16	C15	1.516(3)
C17	C12	1.513(3)	C22	O23	1.184(3)
C17	C16	1.512(3)	C22	C24	1.491(3)
C19	C20	1.514(3)	C31	C30	1.390(3)
C2	C3	1.426(3)	C10	C9	1.398(4)
C2	N1	1.362(3)	C6	C5	1.351(3)
C2	C7	1.410(3)	C28	C29	1.359(4)
C14	C15	1.517(3)	C8	C9	1.346(4)
C26	C20	1.502(3)	C29	C30	1.393(4)

## Table 8 Bond Angles for (*R*,*R*,*R*)-5

Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°
C12	011	C3	118.62(15)	C13	C12	011	108.25(15)
C22	O21	C20	115.99(18)	C17	C12	011	112.18(16)
C19	018	C13	118.29(15)	C17	C12	C13	109.27(15)
C14	C13	018	108.03(15)	C5	C4	C3	120.5(2)
C12	C13	018	110.00(14)	C10	N1	C2	116.3(2)
C12	C13	C14	109.71(16)	C28	C27	C26	120.1(3)
C16	C17	C12	111.20(18)	C6	C7	C2	119.7(2)
O18	C19	O25	125.93(18)	C8	C7	C2	117.1(2)
C20	C19	O25	125.60(18)	C8	C7	C6	123.1(2)
C20	C19	018	108.45(17)	C15	C16	C17	110.79(18)
N1	C2	C3	118.42(19)	O23	C22	O21	122.5(2)
C7	C2	C3	118.8(2)	C24	C22	O21	110.3(2)
C7	C2	N1	122.8(2)	C24	C22	O23	127.2(3)
C15	C14	C13	110.34(17)	C16	C15	C14	111.25(17)
C27	C26	C20	119.1(2)	C30	C31	C26	119.9(3)
C31	C26	C20	121.0(2)	С9	C10	N1	125.7(3)
C31	C26	C27	119.9(2)	C5	C6	C7	120.3(2)
C2	C3	011	115.36(17)	C29	C28	C27	120.9(3)
C4	C3	011	124.97(19)	C6	C5	C4	121.1(2)
C4	C3	C2	119.7(2)	С9	C8	C7	120.3(3)
C19	C20	021	110.22(17)	C8	C9	C10	117.7(3)
C26	C20	O21	106.66(15)	C30	C29	C28	120.0(3)
C26	C20	C19	113.73(17)	C29	C30	C31	119.2(3)



ORTEP diagram of the compound (R,R,R)-5 (50% probability factor for thermal ellipsoids) CCDC-1853111

Details	Compound ( <i>R,R</i> )-1-( <i>R</i> )-MA
	CCDC-1853113
Empirical Formula	$C_{23}H_{25}NO_5$
Formula Weight	395.44
Temperature	293(2)
Wavelength	0.71073A
Crystal system	Monoclinic
Space group	12
Unit cell dimensions	a = 10.7133(9) Å
	b = 12.3487(8) Å
	c = 15.4466(15) Å
	$\alpha$ = 90°
	β = 98.90°
	$\gamma = 90^{\circ}$
Volume	2018.9(3)
Z	8
(Density calculated)	1.323
Absorption coefficient(µ)	0.092
F(000)	804.0
Crystal size	-
2θ range for data collection	6.92 to 58.08°
Reflections collected	4426
Independent reflections	3392[R(int) = 0.0419]
Refinement method	Least Squares minimisation
Data / restraints /	3392/0/281
Parameters	
Goodness of fit on F2	1.016
Final R indices	R <sub>1</sub> =0.0569, wR <sub>2</sub> = 0.1225
[I>2sigma(I)]	
R indices (all data)	R <sub>1</sub> = 0.0950, wR <sub>2</sub> = 0.1495
Largest difference peak and	0.17/-0.20
hole	

## X-ray crystal data for CCDC No 1853111 (*R*,*R*,)-1-(*R*)-MA

### Table 10 Bond Lengths for (*R*,*R*)-1-(*R*)-MA

Atom Atom		Length/Å	Atom Atom	Length/Å
O3	C5	1.449(4)	C11 C19	1.512(5)
O3	C7	1.367(4)	C11 C4	1.380(5)
O4	C18	1.280(5)	C11 C6	1.382(5)
N6	C8	1.325(5)	C17 C28	1.400(5)
N6	C10	1.368(4)	C18 C19	1.533(6)
08	C20	1.418(5)	C20 C3AA	1.523(5)
O10	C18	1.226(5)	C25 C0AA	1.531(5)
012	C19	1.418(5)	C26 C28	1.352(6)
C1	C10	1.414(5)	C27 C2	1.361(6)
C1	C26	1.406(5)	C0AAC1AA	1.518(6)
C1	C27	1.412(5)	C4 C2AA	1.388(7)
C5	C20	1.524(5)	C6 C14	1.390(6)
C5	C25	1.532(5)	C3AAC1AA	1.532(6)
C7	C10	1.414(5)	C2AA C15	1.379(8)
C7	C17	1.355(5)	C14 C15	1.353(7)
C8	C2	1.390(6)		

Table 11 Bond Angles for (*R*,*R*)-1-(*R*)-MA

Atom	Atom	Atom	Angle/°	Atom Atom Atom	Angle/°
C7	03	C5	119.2(3)	O10 C18 C19	117.7(4)
C8	N6	C10	121.3(3)	O12 C19 C11	111.1(3)
C26	C1	C10	119.0(3)	O12 C19 C18	109.3(3)
C26	C1	C27	124.0(4)	C11 C19 C18	109.1(3)
C27	C1	C10	117.0(3)	O8 C20 C5	111.1(3)
O3	C5	C20	104.7(3)	O8 C20 C3AA	108.9(3)
O3	C5	C25	111.2(3)	C3AA C20 C5	108.9(3)
C20	C5	C25	110.1(3)	C0AA C25 C5	108.5(3)
O3	C7	C10	112.9(3)	C28 C26 C1	119.6(4)
C17	C7	O3	127.7(3)	C2 C27 C1	121.0(4)
C17	C7	C10	119.4(3)	C26 C28 C17	121.6(4)
N6	C8	C2	121.2(4)	C1AAC0AA C25	109.9(4)
N6	C10	C1	120.1(3)	C27 C2 C8	119.3(4)
N6	C10	C7	120.1(3)	C11 C4 C2AA	120.2(4)
C7	C10	C1	119.7(3)	C11 C6 C14	120.6(4)
C4	C11	C19	121.8(4)	C20 C3AAC1AA	111.5(3)
C4	C11	C6	118.6(4)	COAAC1AAC3AA	110.1(3)
C6	C11	C19	119.5(3)	C15 C2AA C4	120.3(5)
C7	C17	C28	120.6(4)	C15 C14 C6	120.4(5)
O4	C18	C19	115.5(3)	C14 C15 C2AA	119.7(5)
O10	C18	O4	126.6(4)		



Figure 50: ORTEP diagram of the compound (R,R,)-1-(R)-MA (50% probability factor for thermal ellipsoids) CCDC-1853113

To further examine the interactions responsible for recognition activity of (R,R)-1 as CSA, the crystal structure of its salt with (R)-Mandelic acid was solved. The crystal of salt of (R,R)-1 with (R) mandelic acid crystallizes in monoclinic space group I2. The deprotonation of mandelic acid is further confirmed by shorter bond length of (C–O) bond (1.22-1.28 Å) of carboxylate. The assembly involves three point interaction between (R,R)-1 and mandelic acid. The salt shows (NH···O) hydrogen bond (1.789 Å) between quinoline 'NH' and (C–O), and (OH···O) hydrogen bond (2.049 Å) between alcoholic 'OH' and (C-O) of carboxylate of mandelic acid. The mandelic acid shows further (CO···O) interaction (2.889 Å) with ethereal 'O' of (R,R)-1. In addition the other 'O' of carboxylate shows strong (CH–O) interaction (2.491 Å) with C-H of quinoline ring figure **50a**. Furthermore the alcoholic OH of mandelic acid shows lateral (OH-C) interaction (2.851 Å) with carbon cyclohexyl ring and with (O-HC) (2.716 Å) of quinoline ring of other (R,R)-1 unit figure **50b**.





Figure 51: UV-vis Spectra of (R,R)-1(1x10<sup>-5</sup> M)





Figure 53: a) Fluorescence Spectra of (R,R)-1 (1 x 10<sup>-5</sup> M), (D)-AA-I and (L)-AA-I (1 x 10<sup>-3</sup>M) in presence of (R,R)-1 in EtOH ( $\lambda_{ex} = 300 \text{ nm}$ ); (left) b) Fluorescence Spectra of (S,S)-1 (1 x10<sup>-5</sup> M) ), (D)-AA-I and (L)-AA-I (1 x 10<sup>-3</sup>M) in presence of (S,S)-1 in EtOH ( $\lambda_{ex} = 300 \text{ nm}$ ) (right).



Figure 54: a) Fluorescence Spectra of (*R*,*R*)-1 (1 x10<sup>-5</sup> M) with increasing concentration of (*L*)-AA-I; (left) b) Job's Plot: NMR titration of (*R*,*R*)-1 with (*L*)-AA-I (right) in CD<sub>3</sub>OD (20 mM conc.) (right).



Figure 55: a) Benesi-Hildebrand plot of (R,R)-1 (1.0 x 10<sup>-5</sup> M in EtOH) in the presence of (D)and (L)-phenyl alanine (AA-I) (left) b) Plot of fluorescence response of (R,R)-1 (1.0 x 10<sup>-5</sup> M in EtOH) in the presence of AA-I (1.0 x 10<sup>-3</sup> M in EtOH) with varying *ee* ratio. (right).



Figure 56: a) Fluorescence Spectra of (R,R)-1 (1 x 10<sup>-5</sup> M), (D)-AA-II and (L)-AA-II (1 x 10<sup>-3</sup> M) in presence of (R,R)-1 in EtOH ( $\lambda_{ex} = 300$  nm); (left) b) Benesi-Hildebrand plot of (R,R)-1 (1.0 x 10<sup>-5</sup> M in EtOH) in the presence of (D)- and (L)-phenyl glycine (AA-II) (right).



Figure 57: a) Fluorescence Spectra of (R,R)-1 (1 x 10<sup>-5</sup> M), (D)-AA-III and (L)-AA-III (1 x 10<sup>-3</sup> M) in presence of (R,R)-1 in EtOH ( $\lambda_{ex} = 300$  nm); (left) b) Benesi-Hildebrand plot of (R,R)-1 (1.0 x 10<sup>-5</sup> M in EtOH) in the presence of (D)- and (L)-proline (AA-III) (right).



Figure 58: a) Fluorescence Spectra of (R,R)-1 (1 x 10<sup>-5</sup> M), (D)-AA-IV and (L)-AA-IV (1 x 10<sup>-3</sup> M) in presence of (R,R)-1 in EtOH ( $\lambda_{ex} = 300$  nm); (left) b) Benesi-Hildebrand plot of (R,R)-1 (1.0 x 10<sup>-5</sup> M in EtOH) in the presence of (D)- and (L)-valine (AA-IV) (right).



Figure 59: a) Fluorescence Spectra of (R,R)-1 (5 x 10<sup>-6</sup> M), (D)-DP-I and (L)-DP-I (1 x 10<sup>-3</sup>) in presence of (R,R)-1 in EtOH ( $\lambda_{ex} = 300 \text{ nm}$ ); (left) b) Fluorescence Spectra of (R,R)-1 (1 x 10<sup>-5</sup> M) with increasing concentration of (L)-DP-I (right).



Figure 60: a) Benesi-Hildebrand plot of (R,R)-1 (1.0 x 10<sup>-5</sup> M in EtOH) in the presence of (D)and (L)-DP-I; (left) b) Fluorescence Spectra of (R,R)-1 (5 x 10<sup>-6</sup> M), (D)-DP-II and (L)-DP-II (1 x 10<sup>-3</sup> M) in presence of (R,R)-1 in EtOH ( $\lambda_{ex} = 300$  nm) (right).



Figure 60: a) Fluorescence Spectra of (R,R)-1 (1 x 10<sup>-5</sup> M) with increasing concentration of (L)-**DP-II** (left); b) Benesi-Hildebrand plot of (R,R)-1 (1.0 x 10<sup>-5</sup> M in EtOH) in the presence of (D)-and (L)-**DP-II**; (right)



Figure 61: Fluorescence Spectra of (*R*,*R*)-1 (5 x 10<sup>-6</sup> M), (*D*)-DP-III and (*L*)-DP-III (1 x 10<sup>-3</sup>M) in presence of (*R*,*R*)-1 in EtOH ( $\lambda_{ex} = 300$  nm)

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