# Supplementary Information

## Stereospecific Diaza-Cope Rearrangement as an Efficient Tool for the Synthesis of DPEDA Pyridine Analogs and Related $C_2$-Symmetric Organocatalysts

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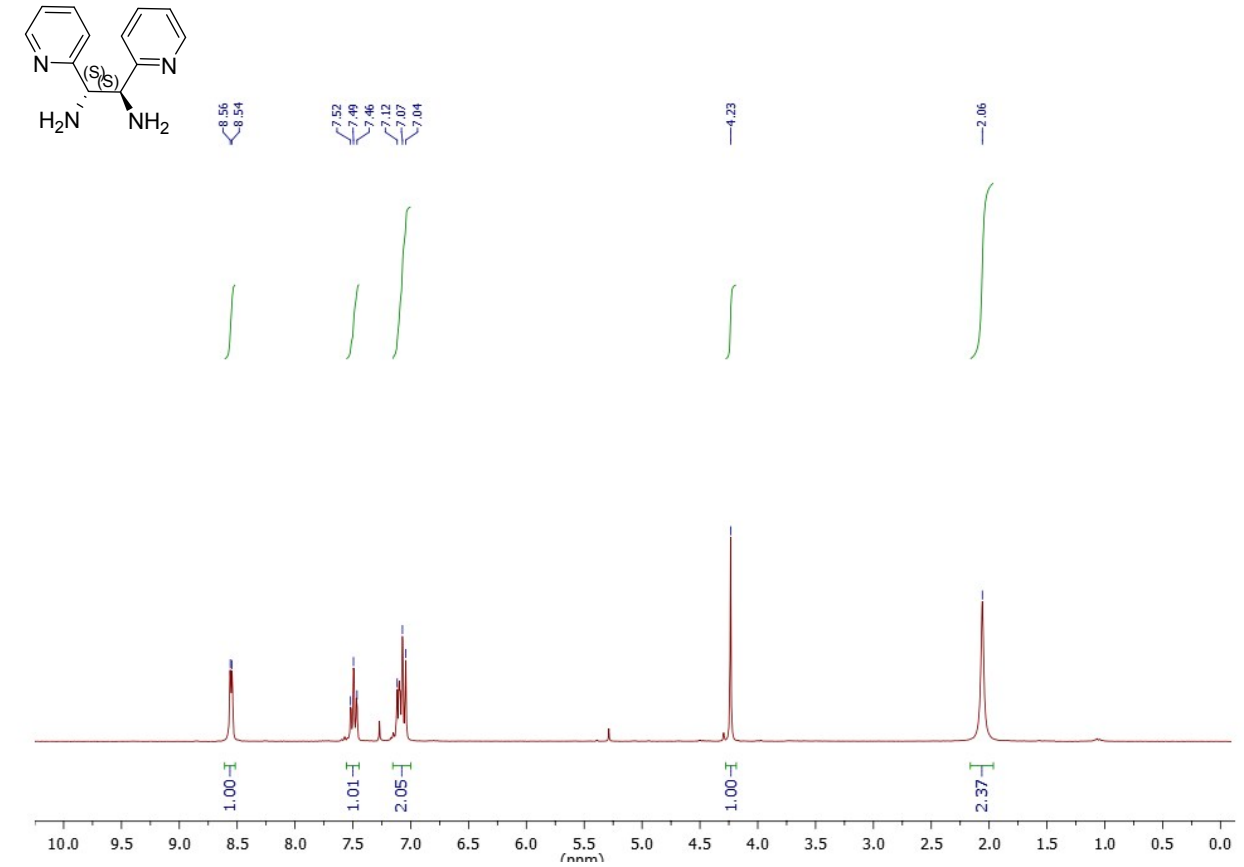
**1. Pictures of $^{1}H$ and $^{13}C$ NMR spectra for novel compounds**

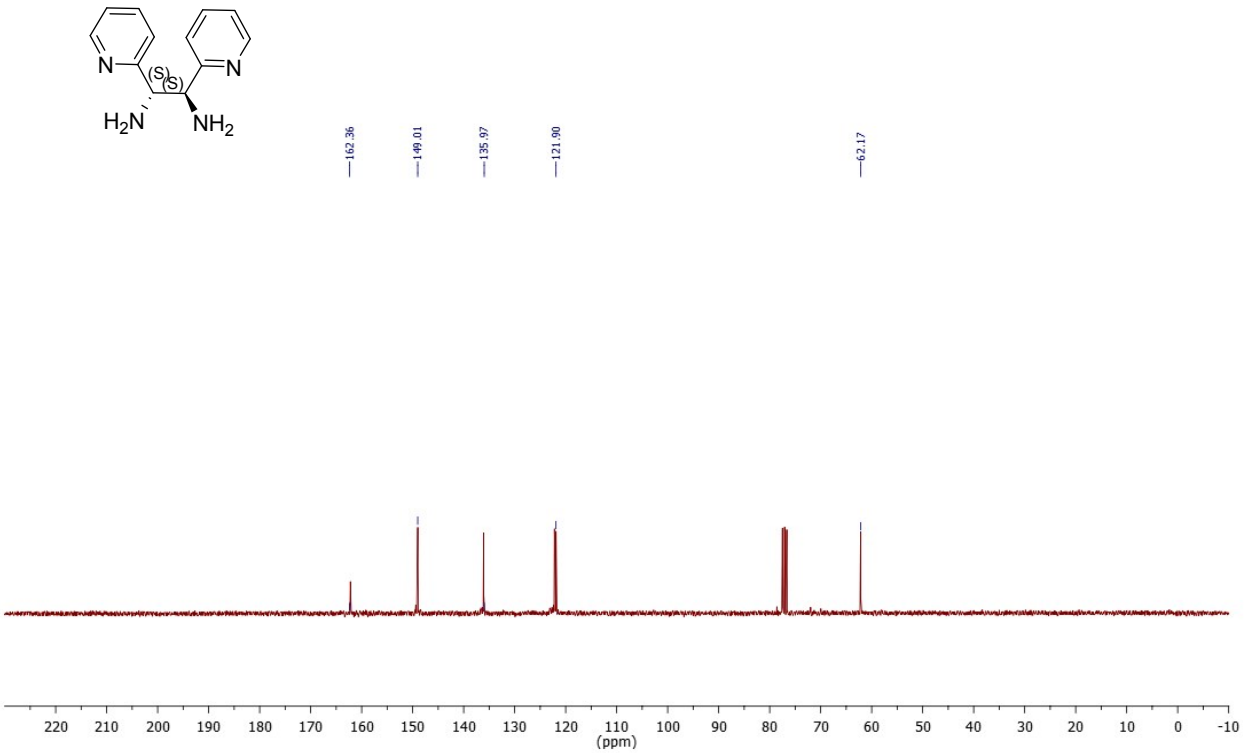
**2. $^{1}H$ NMR data for known compounds**

**3. HPLC data**

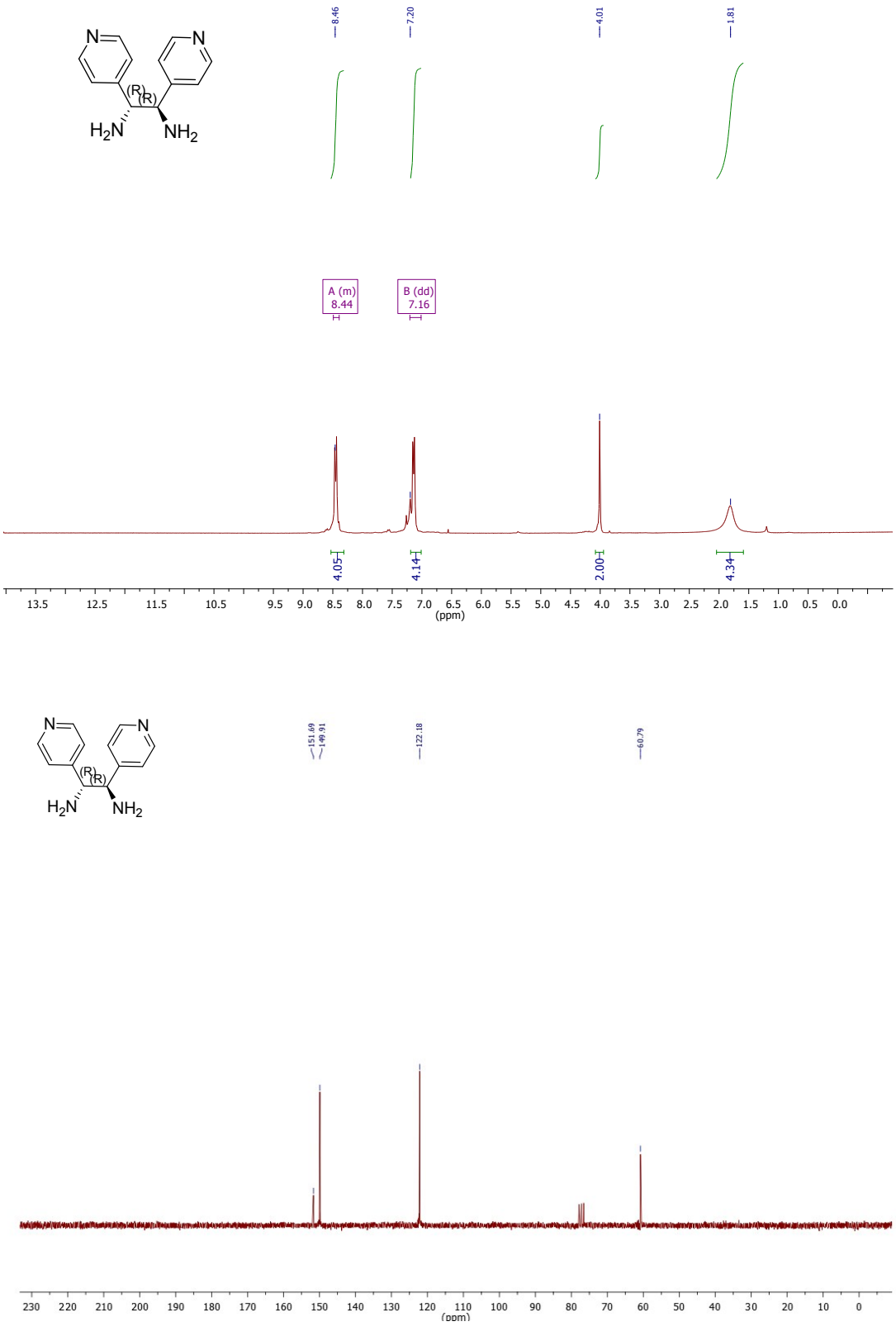
# 1. Pictures of $^{1}H$ and $^{13}C$ NMR spectra for novel compounds

**(1*S*,2*S*)-1,2-Di(pyridin-2-yl)ethane-1,2-diamine** (**2a**):

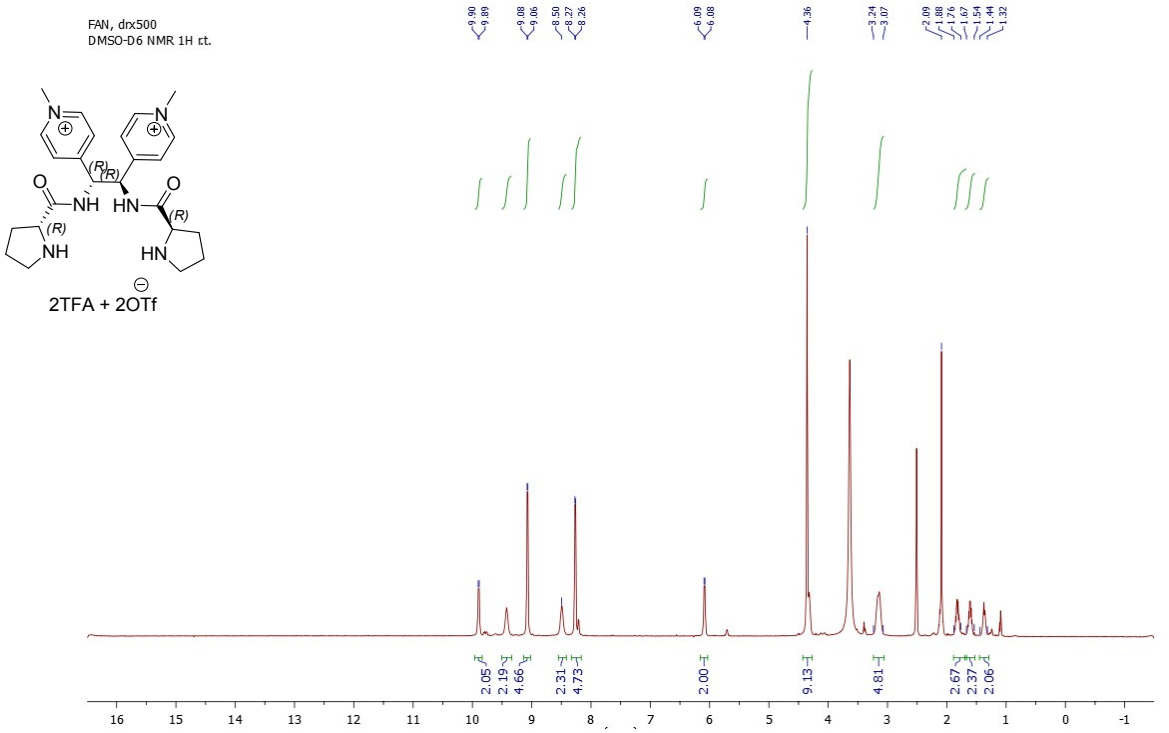


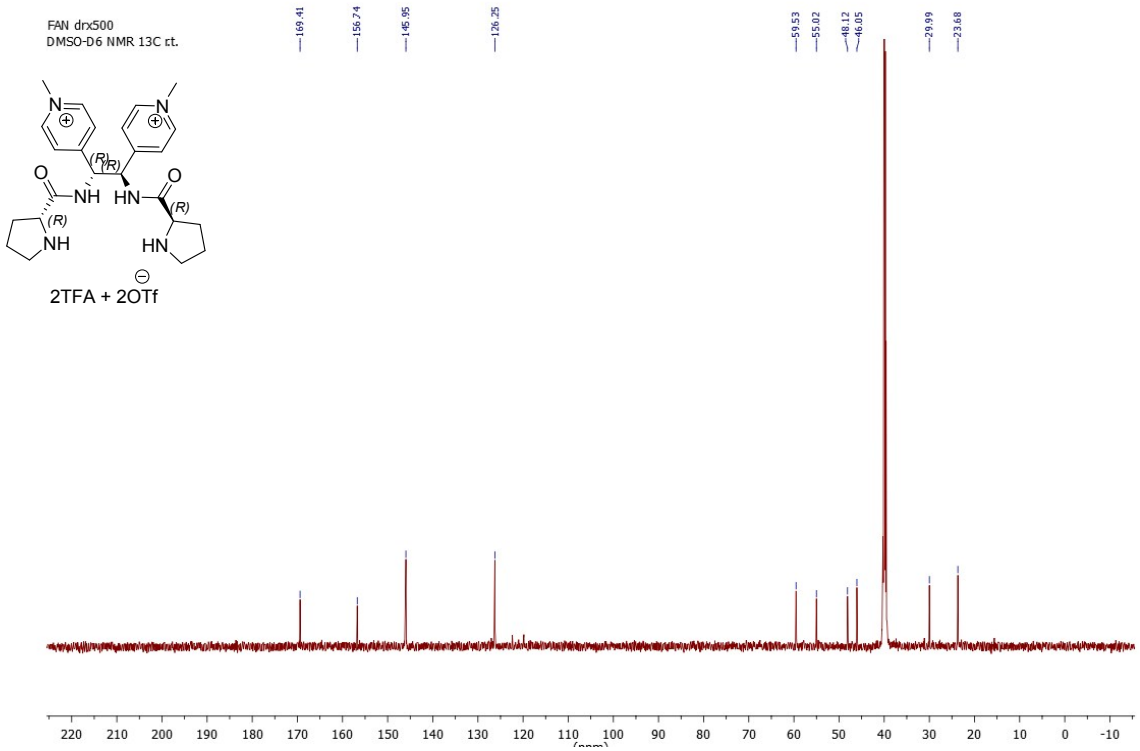



**(1*R*,2*R*)-1,2-Di(pyridin-4-yl)ethane-1,2-diamine (2b)**:

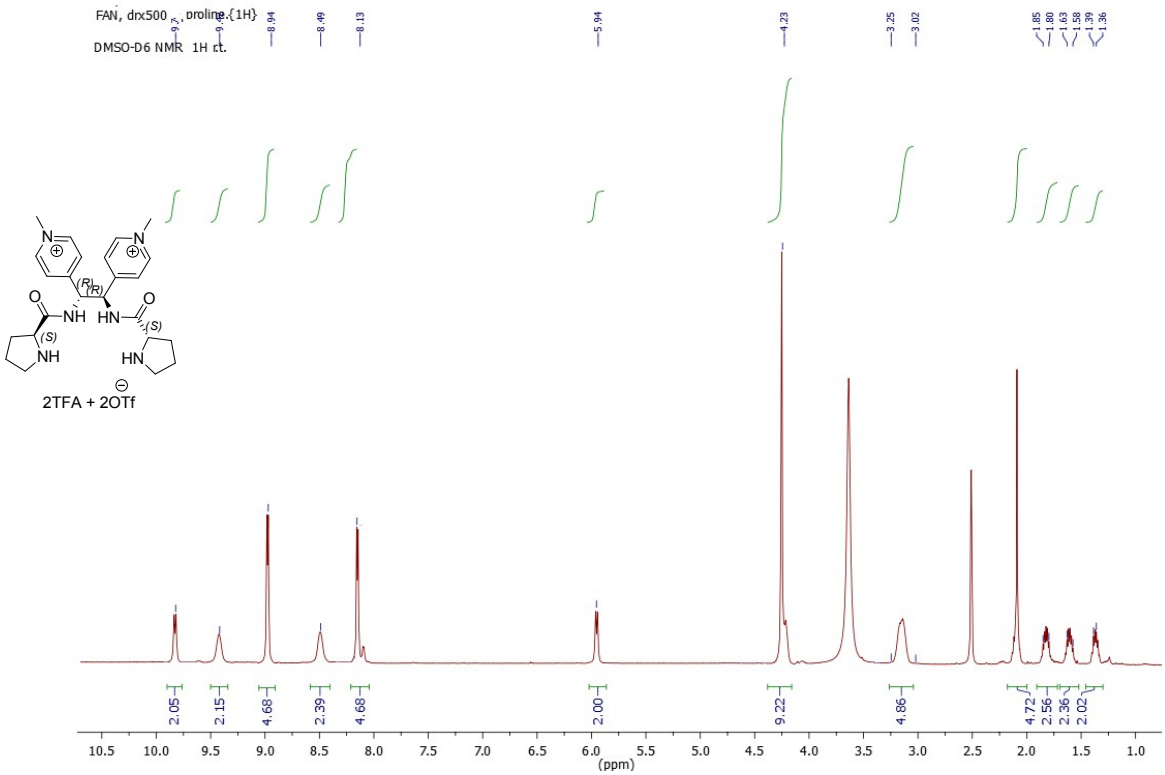


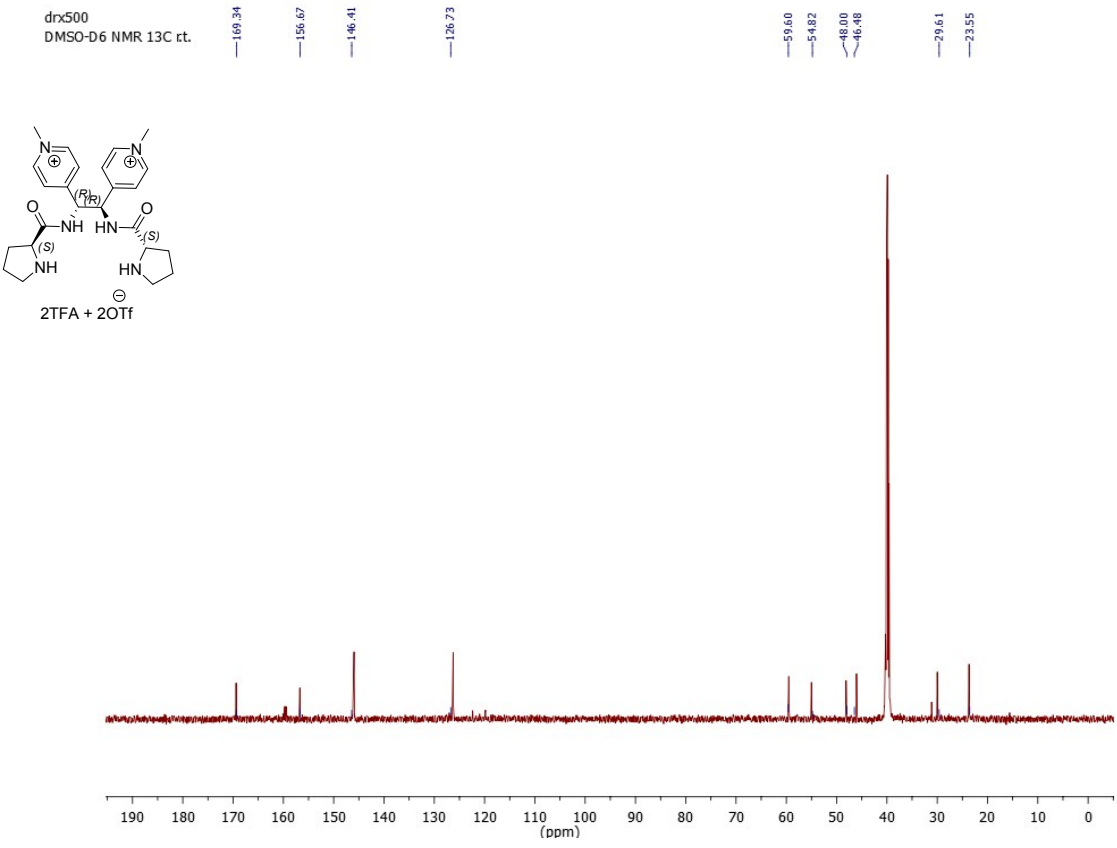
**(1*R*,2*R*)-N,N′-Bis[(*R*)-prolyl]-1,2-bis(1-methylpyridin-4-yl)ethane-1,2-diamine bis(triflate)/bis(trifluoroacetate)** (*RR*-**1b**):



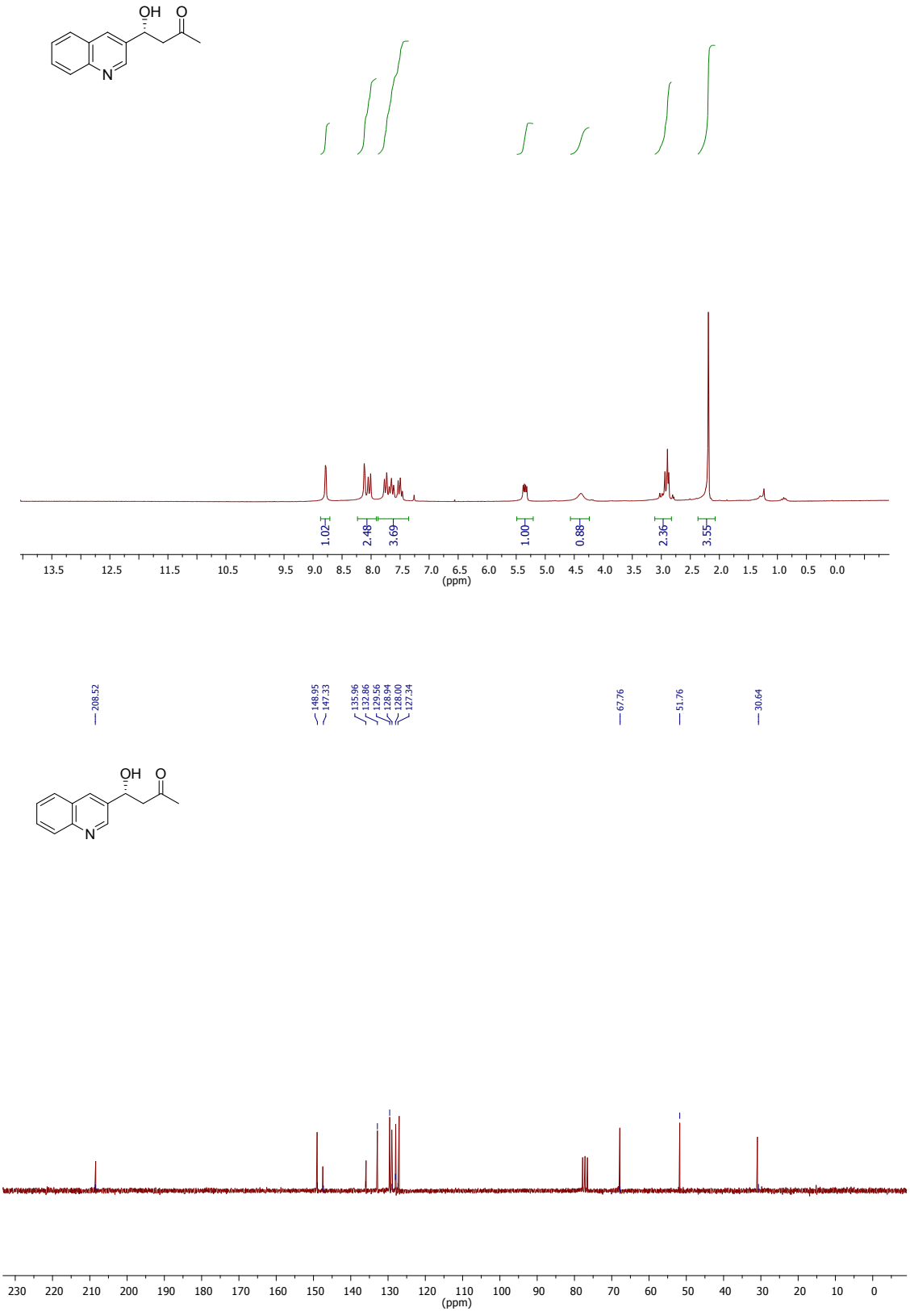



**(1*R*,2*R*)-N,N′-Bis[(*S*)-prolyl]-1,2-bis(1-methylpyridin-4-yl)ethane-1,2-diamine Bis(triflate)/Bis(trifluoroacetate)** (*RS*-**1b**):

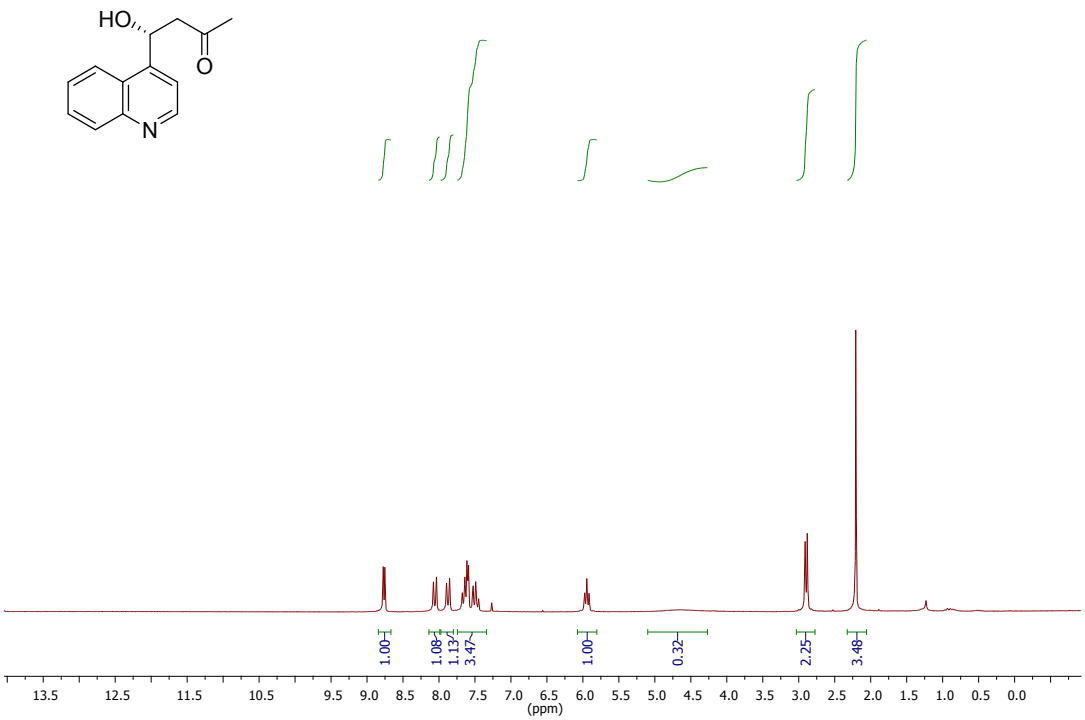


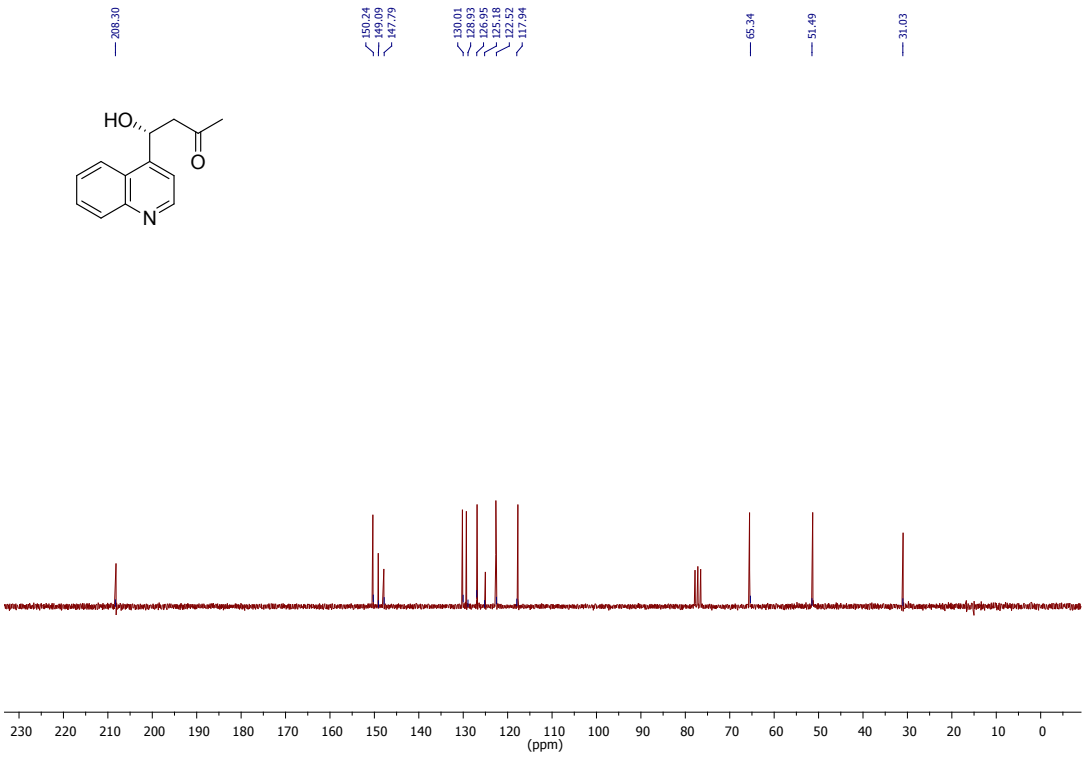



**(*R*)-4-Hydroxy-4-(quinolin-3-yl)butan-2-one (10d)**:



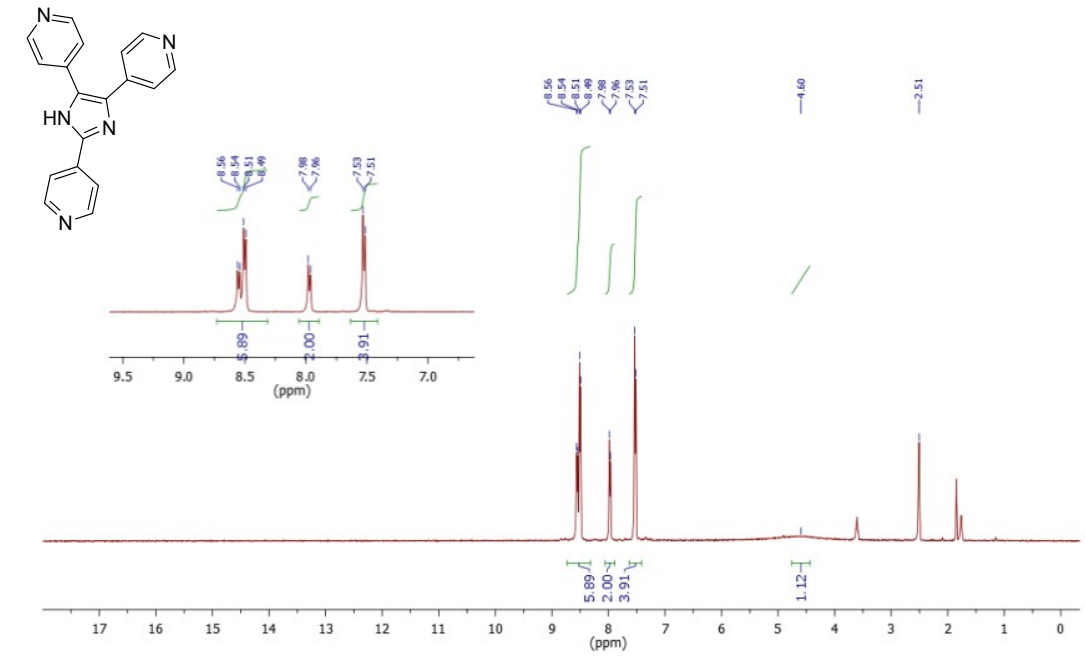
**(*R*)-4-Hydroxy-4-(quinolin-4-yl)butan-2-one (10e)**:



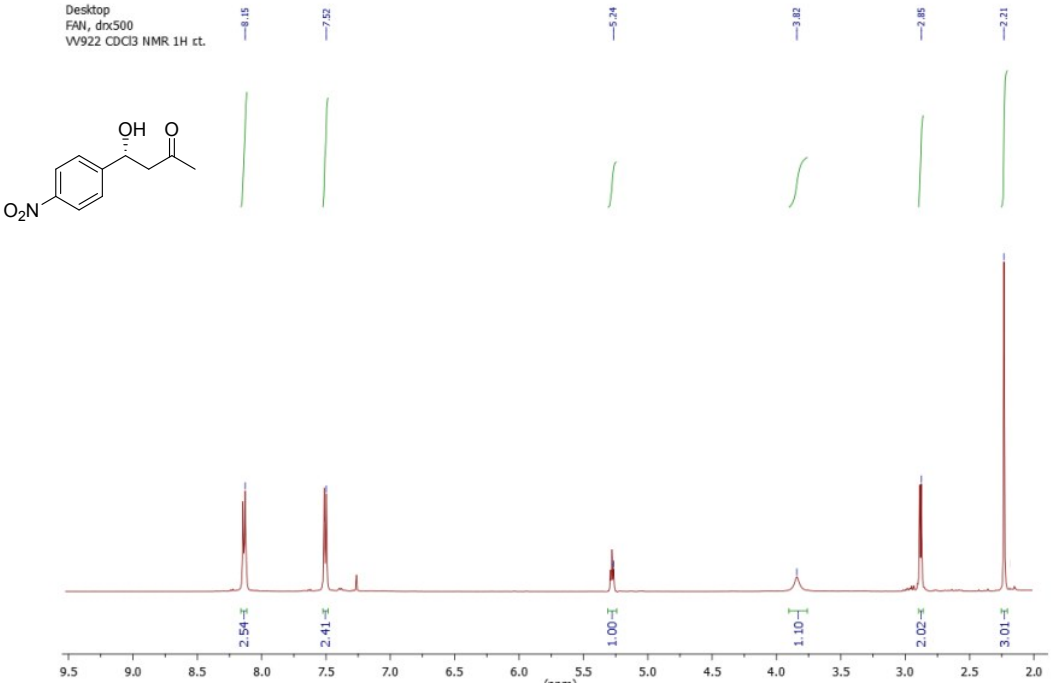



## 2. $^1$H NMR – data for known compounds

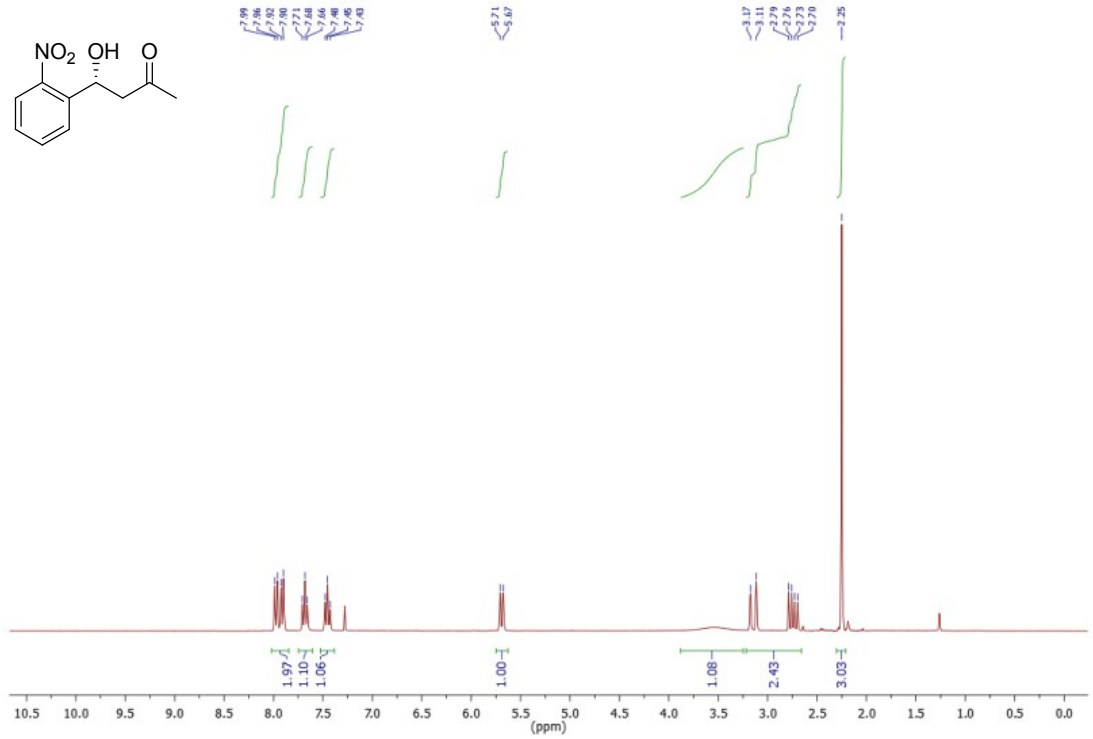
**4,4',4''-(1H-imidazole-2,4,5-triyl)tripyridine (5b)** [1]: $^1$H NMR (300 MHz, $d_6$-DMSO ): δ 8.56-8.54 (d, 2H), 8.51-8.49 (d, Hz, 4H), 7.98 −7.96 (d, 2H), 7.53-7.51 (d, 4H), 4.60 (s (*br*), 1H) ppm.



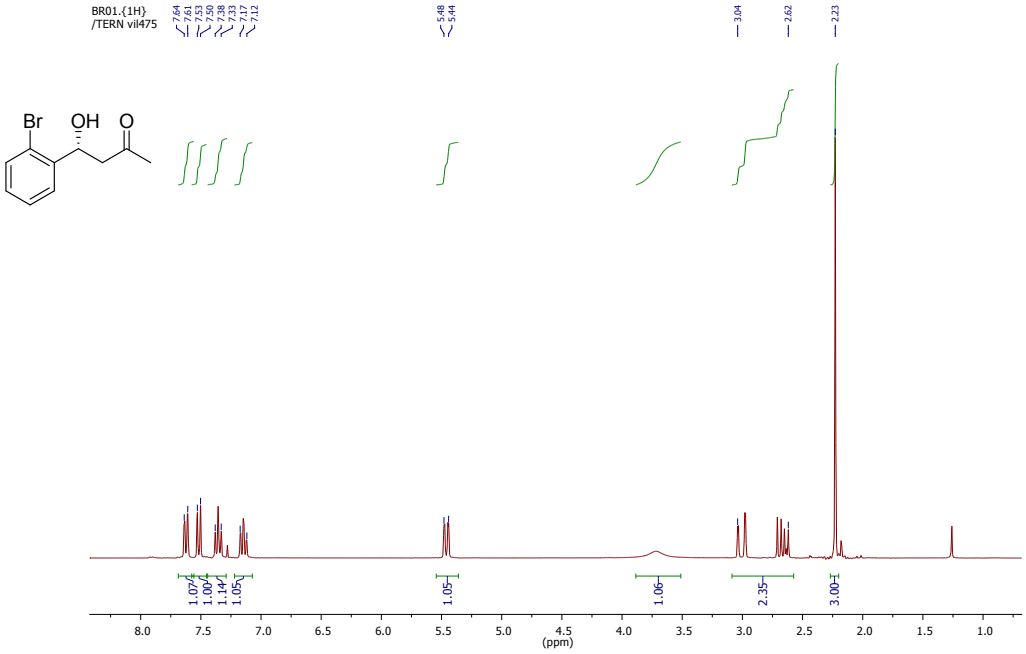

**(*R*)-4-Hydroxy-4-(4-nitrophenyl)butan-2-one (10a)**:[2] $^1$H NMR (500 MHz, $CDCl_3$): 8.15 (d, 2H), 7.52 (d, 2H), 5.24 (t, 1H), 3.82 (s, (*br*) 1H), 2.85 (d, 2H), 2.21 (s, 3H) ppm.



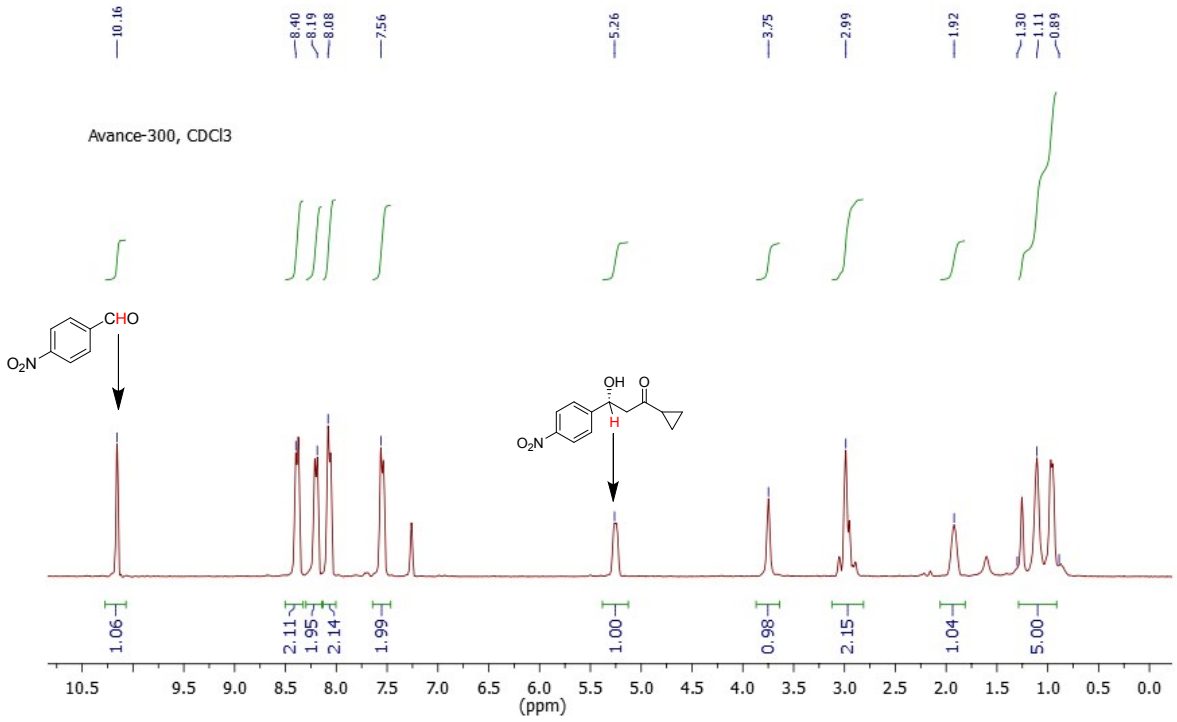
**(*R*)-4-Hydroxy-4-(2-nitrophenyl)butan-2-one (10b)**:[3] $^1$H NMR (300 MHz, $CDCl_3$): 7.99-7.90 (m, 2H), 7.68 (t, 1H), 7.45 (t, 1H), 5.70 (d, 1H), 3.17 – 2.70 (m, 2H), 2.25 (s, 3H) ppm.



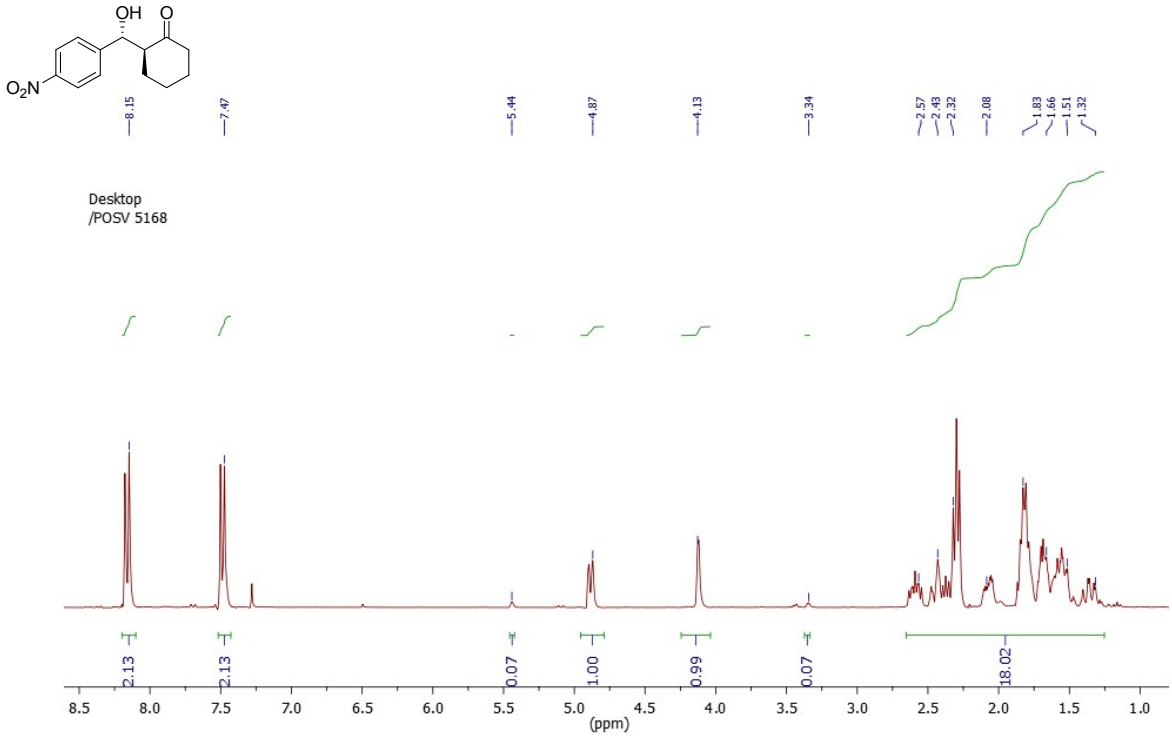

**(*R*)-4-(2-bromophenyl)-4-hydroxybutan-2-one (10c)**:[2] $^1$H NMR (300 MHz, $CDCl_3$): 7.64 (d, 1H), 7.53 (d, 1H), 7.38 (t, 1H), 7.12 (m, 1H), 5.46 (m, 1H), 3.70 (s, (*br*), 1H), 3.04 – 2.62 (m, 2H), 2.23 (s, 3H) ppm.



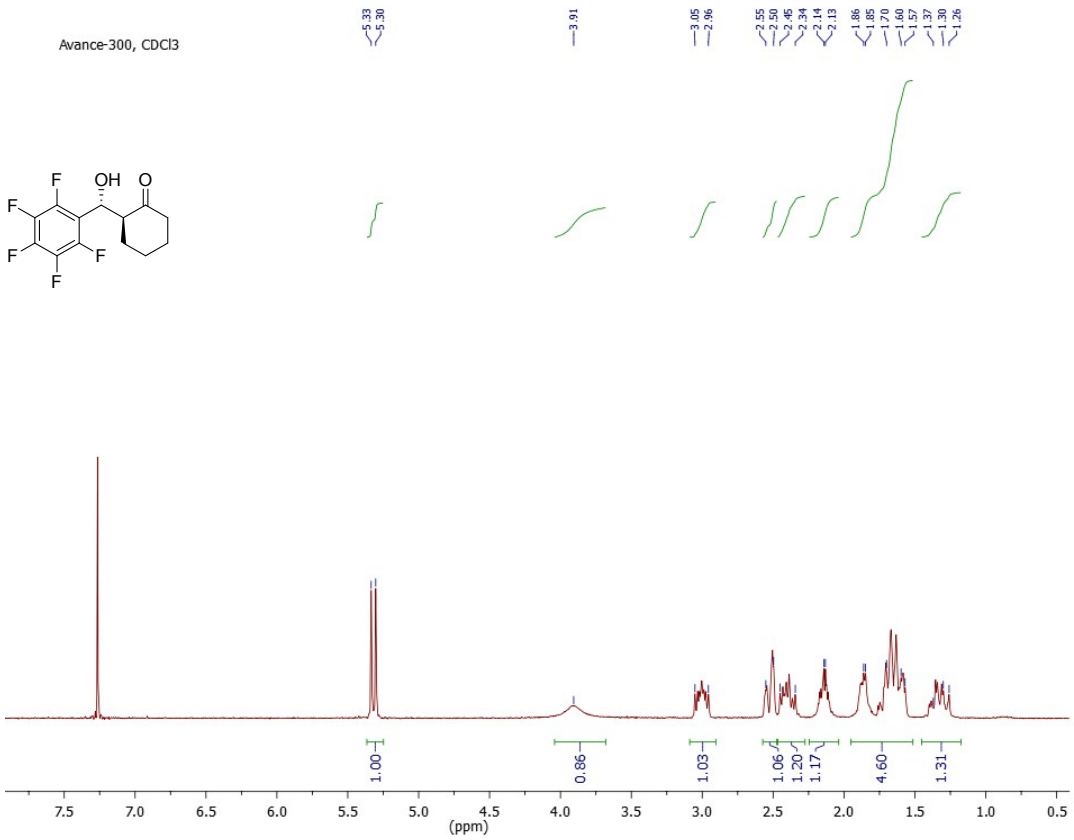
**(*R*)-1-Cyclopropyl-3-hydroxy-3-(4-nitrophenyl)propan-1-one (10f)**:[4] conversion ≈ 50%. $^1$H NMR (300 MHz, $CDCl_3$): 10.16 (s, 1H), 8.40 (d, 2H), 8.19 (d, 2H), 8.08 (d, 2H), 7.56 (d, 2H), 5.26 (m, 1H), 3. 75 (s, 1H), 2.99 (m, 2H), 1.92 (m, 1H), 1.30-0.89 (m, 4H) ppm.



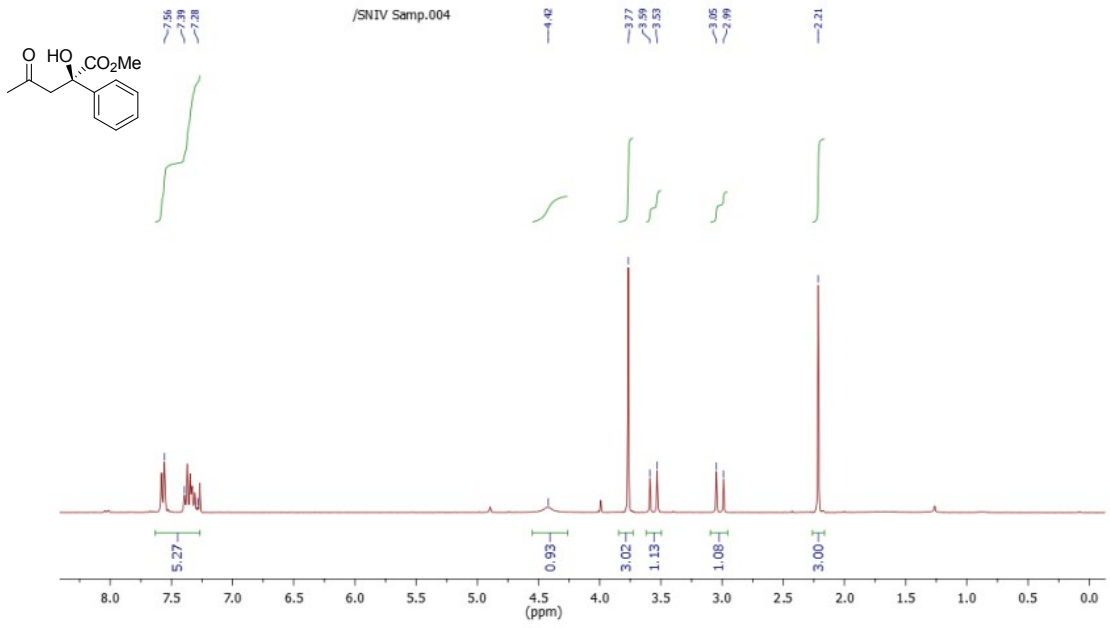

**(*S*)-2-((*R*)-Hydroxy(4-nitrophenyl)methyl)cyclohexanone (10g)**:[2] $^1$H NMR (300 MHz, $CDCl_3$): 8.15 (d, 2H), 7.47 (d, 2H), 4.87 (d, 1H), 4.13 (m, 1H), 2.57-2.50 (m, 1H), 2.43-1.32 (m, 8H) ppm.



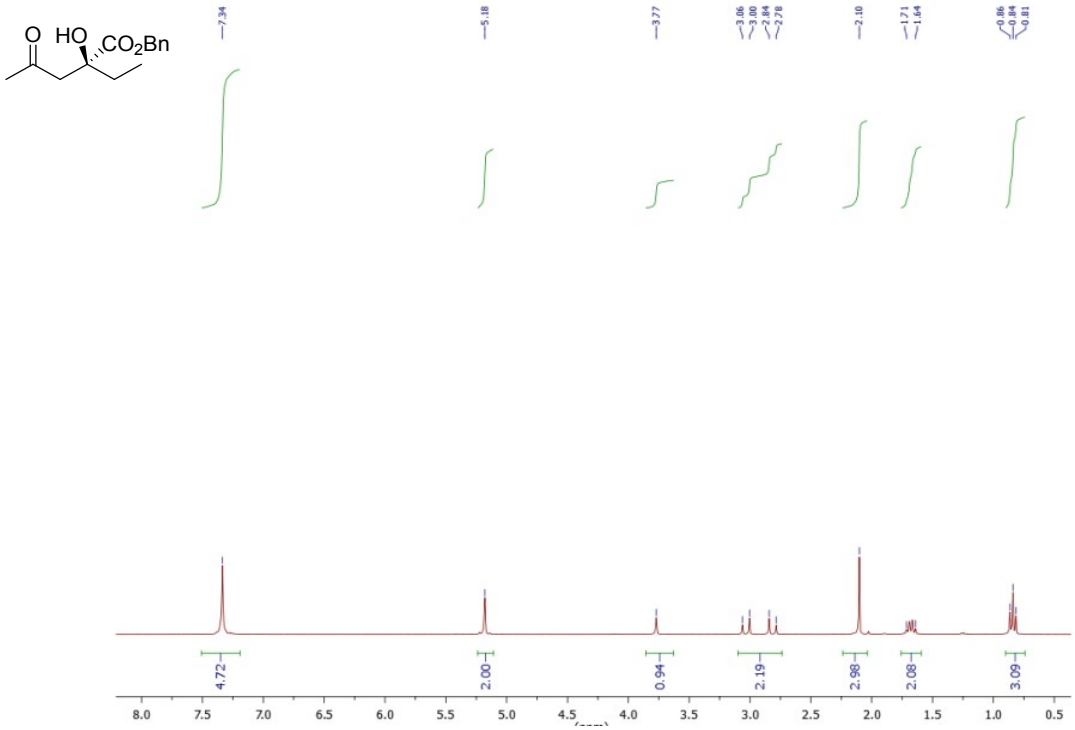
**(*S*)-2-((*R*)-Hydroxy(perfluorophenyl)methyl)cyclohexanone (10h)**:[5] $^1$H NMR (300 MHz, $CDCl_3$): 5.33-5.30 (d, 1H), 3.91 (s, (*br*), 1H), 3.05-2.96 (m, 1H), 2.55-2.34 (m, 3H), 2.20-2.10 (m, 1H), 1.90-1.80 (m, 1H), 1.70 – 1.15 (m, 3H), 1.40-1.26 (m, 1H) ppm.



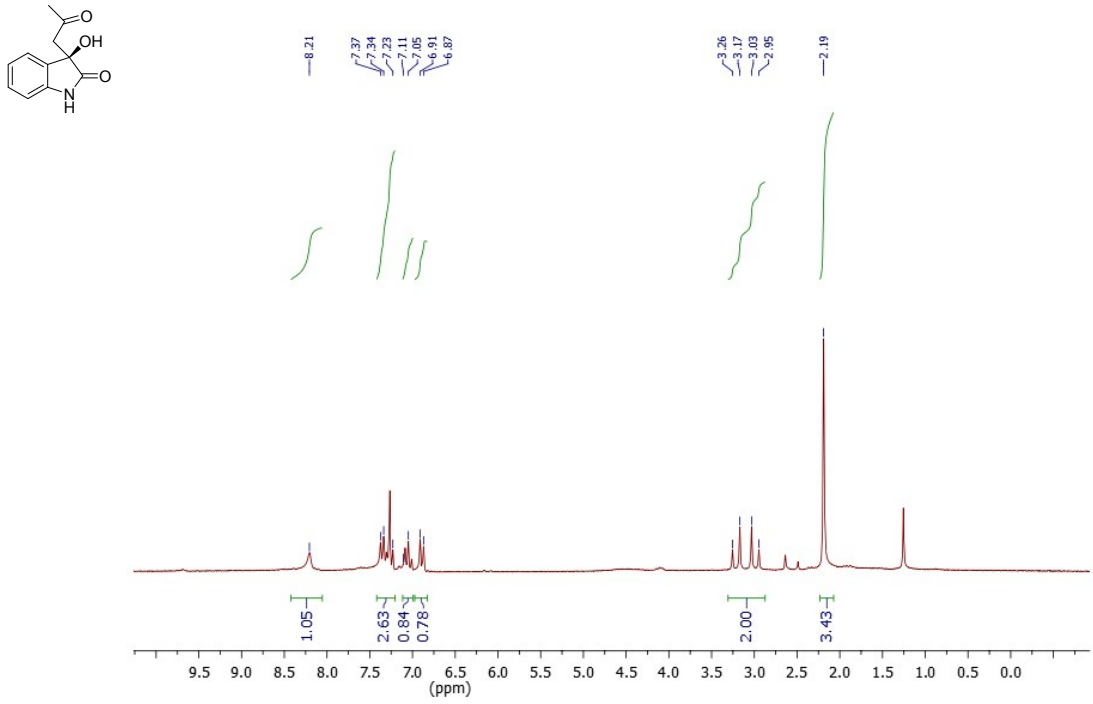

**(*R*)-Methyl-2-hydroxy-4-oxo-2-phenylpentanoate (11a)**:[6] $^1$H NMR (300 MHz, $CDCl_3$): 7.56 (d, 1H), 7.39-7.28 (m, 4H), 4.42 (s, (*br*), 1H), 3.77 (s, 3H), 3.59 and 3.53 – 3.05 and 2.99 (dd, 2H), 2.21 (s, 3H) ppm.



**(*S*)-Benzyl-2-ethyl-2-hydroxy-4-oxopentanoate (11b)**:[6] $^1$H NMR (300 MHz, $CDCl_3$): 7.34 (m, 5H), 5.18 (s, 2H), 3.77 (s, 1H), 3.06-2.77 (dd, 2H), 2.10 (s, 3H), 1.71-1.64 (m, 2H), 0.86 – 0.81 (t, 3H) ppm.

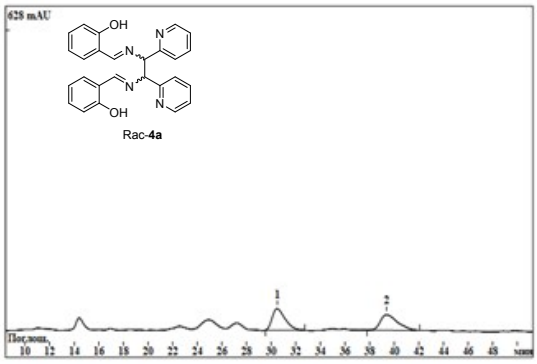



**(*R*)-3-Hydroxy-3-(2-oxopropyl)indolin-2-one (12)**:[7] $^1$H NMR (300 MHz, $CDCl_3$): 8.21 (s, (*br*), 1H), 7.37-7.23 (m, 2H), 7.11-7.05 (m, 1H), 6.91-6.87 (m, 1H), 3.26-2.95 (dd, 2H), 2.19 (s, 3H) ppm.

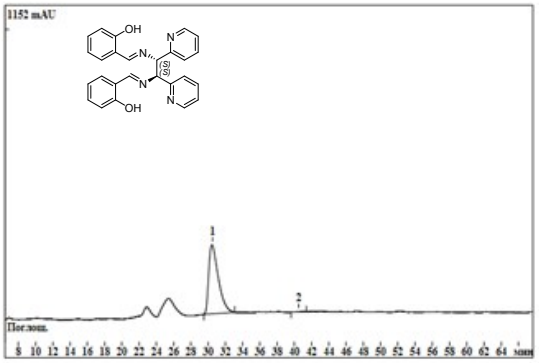


## 3. HPLC data

**2,2'-((1S,2S)-1,2-di(pyridin-2-yl)ethane-1,2-diyl)bis(azan-1-yl-1-ylidene)bis(methan-1-yl-1-ylidene)diphenol (4a):** *Chiralpak AD-H*, 1 mL/min, *n*-hexane/*i*-PrOH = 70:30, λ=220 nm, $t_{major}$ = 30.5 min, $t_{minor}$ = 40.5 min.

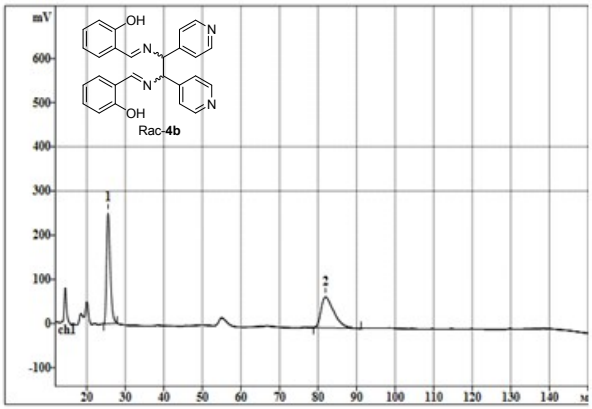



| | мин | mAU*сек | % |
|---|---|---|---|
| 1 | 30.49 | 3175.34 | 50.78 |
| 2 | 39.38 | 3078.14 | 49.22 |
| 2 | 89.98 | 6253.48 | 100.00 |

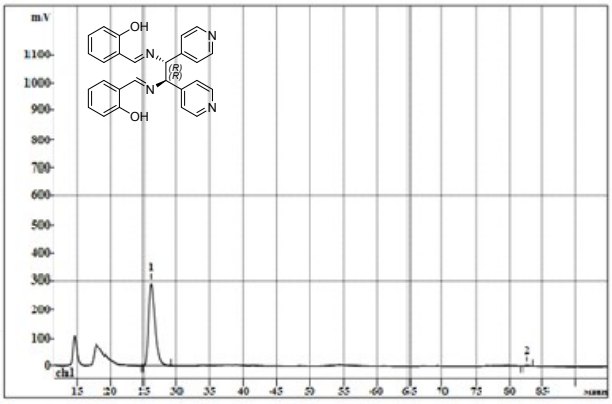



| | мин | mAU*сек | % |
|---|---|---|---|
| 1 | 30.51 | 19678.16 | 99.79 |
| 2 | 40.5 | 40.74 | 0.21 |
| 2 | 112 | 19718.90 | 100.00 |

**2,2'-((1R,2R)-1,2-di(pyridin-4-yl)ethane-1,2-diyl)bis(azan-1-yl-1-ylidene)bis(methan-1-yl-1-ylidene)diphenol (4b)**:*Chiralpak AD-H*, 1 mL/min, *n*-hexane/*i*-PrOH = 70:30, λ=220 nm, $t_{major}$ = 26.1 min, $t_{minor}$ = 82.6 min.

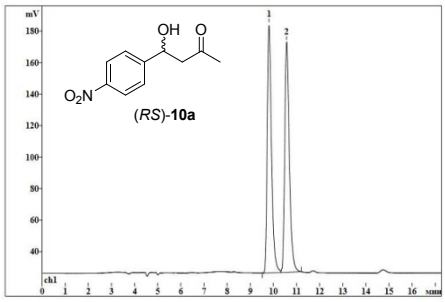



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 25.53 | 16701.69 | 50.98 |
| 2 | 81.94 | 16057.78 | 49.02 |
| 2 | 175.5 | 32759.48 | 100.00 |

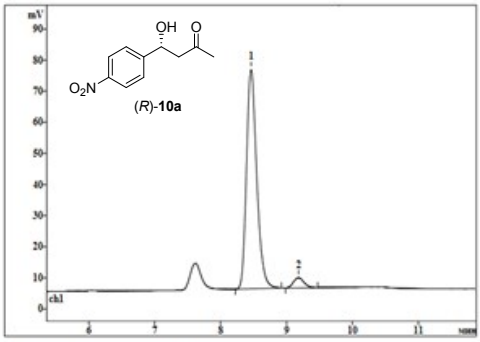



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 26.1 | 20748.00 | 99.59 |
| 2 | 82.64 | 84.52 | 0.41 |
| 2 | 94.63 | 20832.51 | 100.00 |

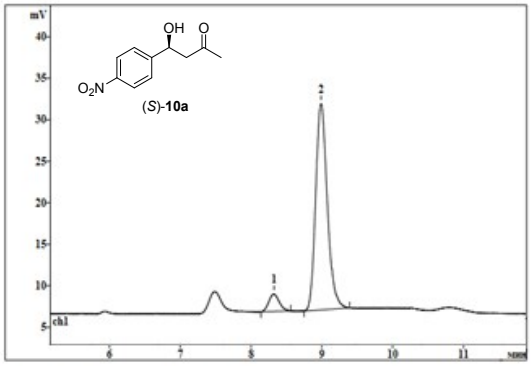
**4-hydroxy-4-(4-nitrophenyl)butan-2-one (10a)**: *Chiralpak OJ-H*, 0.8 mL/min, *n*-hexane/*i*-PrOH =70:30, λ = 254 nm, $t_1$ = 9.8 min, $t_2$ = 10.6 min.




| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 9.81 | 2020.45 | 50.00 |
| 2 | 10.57 | 2020.72 | 50.00 |
| 2 | 17.27 | 4041.17 | 100.00 |

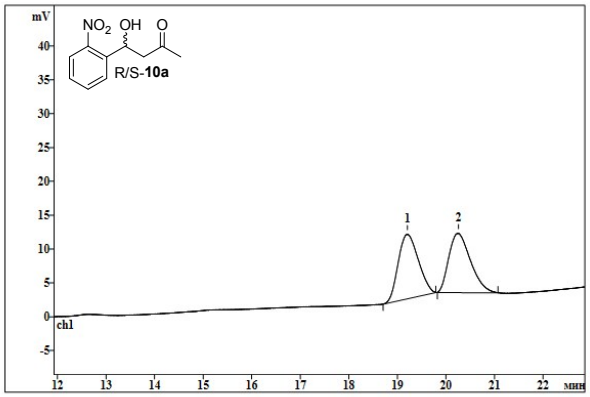



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 8.462 | 760.67 | 95.32 |
| 2 | 9.183 | 37.38 | 4.68 |
| 2 | 14.27 | 798.05 | 100.00 |

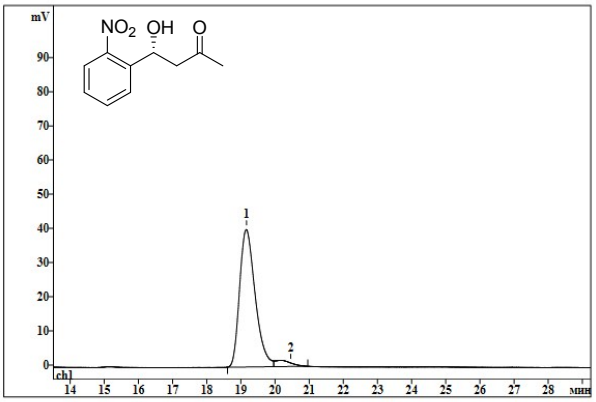



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 8.32 | 21.38 | 7.01 |
| 2 | 8.988 | 283.79 | 92.99 |
| 2 | 13.93 | 305.17 | 100.00 |

**(*R*)-4-Hydroxy-4-(2-nitrophenyl)butan-2-one (10b)**:*Chiralpak AD-H*, 1 mL/min, *n*-hexane/*i*-PrOH = 70:30, λ=254 nm, $t_{major}$ = 19.2 min, $t_{minor}$ = 20.5 min.

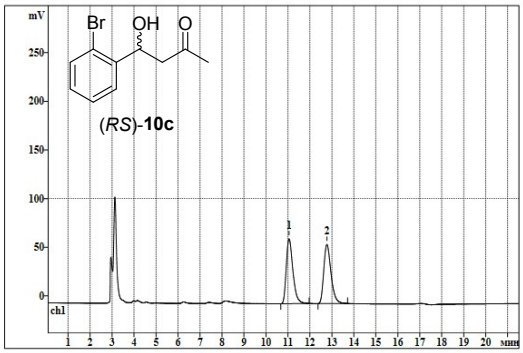



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 19.2 | 274.67 | 50.16 |
| 2 | 20.25 | 272.88 | 49.84 |
| 2 | 50.1 | 547.56 | 100.00 |

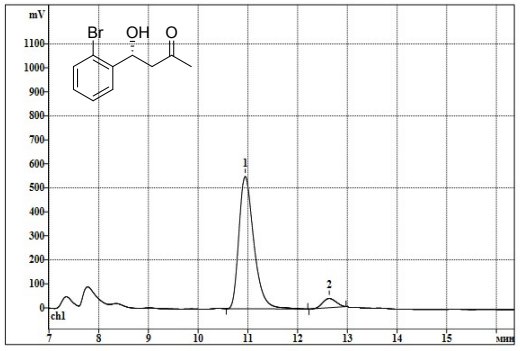



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 19.16 | 1278.25 | 95.60 |
| 2 | 20.46 | 58.83 | 4.40 |
| 2 | 33.3 | 1337.09 | 100.00 |

**(*R*)-4-(2-bromophenyl)-4-hydroxybutan-2-one (10c)**: *Chiralpak OJ-H*, 0.8 mL/min, *n*-hexane/*i*-PrOH = 90:10, λ = 220 nm, $t_{major}$ = 10.9 min, $t_{minor}$ = 12.6 min.

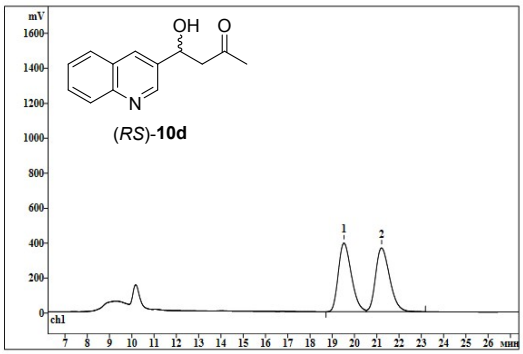



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 11.05 | 1398.66 | 50.13 |
| 2 | 12.77 | 1391.44 | 49.87 |
| 2 | 32.99 | 2790.09 | 100.00 |

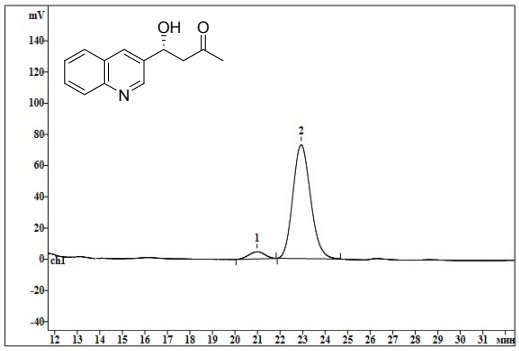



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 10.95 | 11541.11 | 94.16 |
| 2 | 12.63 | 715.86 | 5.84 |
| 2 | 29.23 | 12256.97 | 100.00 |

**(*R*)-4-hydroxy-4-(quinolin-3-yl)butan-2-one (10d)**: *Chiralpak AD-H*, 1 mL/min, *n*-hexane/*i*-PrOH = 90:10, λ=220 nm, $t_{major}$ = 22.9 min, $t_{minor}$ = 21.0 min.

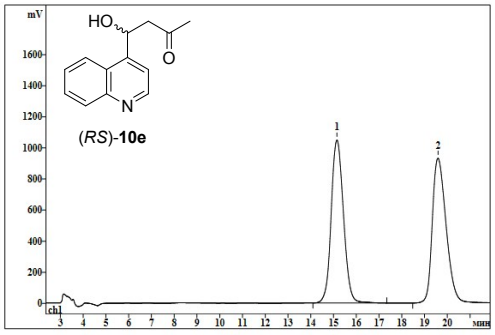



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 19.52 | 16030.33 | 49.92 |
| 2 | 21.21 | 16082.45 | 50.08 |
| 2 | 39.98 | 32112.79 | 100.00 |

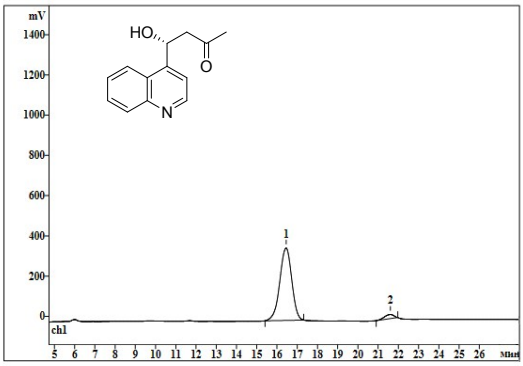



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 20.98 | 222.72 | 5.28 |
| 2 | 22.94 | 3993.13 | 94.72 |
| 2 | 32.84 | 4215.85 | 100.00 |

**(*R*)-4-hydroxy-4-(quinolin-4-yl)butan-2-one (10e)**:*Chiralpak OJ-H*, 1 mL/min, *n*-hexane/*i*-PrOH = 90:10, λ=220 nm, $t_{major}$ = 16.4 min, $t_{minor}$ = 21.6 min.

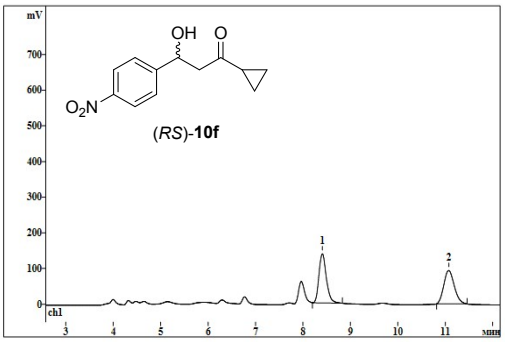



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 15.15 | 39375.37 | 50.10 |
| 2 | 19.59 | 39214.67 | 49.90 |
| 2 | 22.85 | 78590.04 | 100.00 |

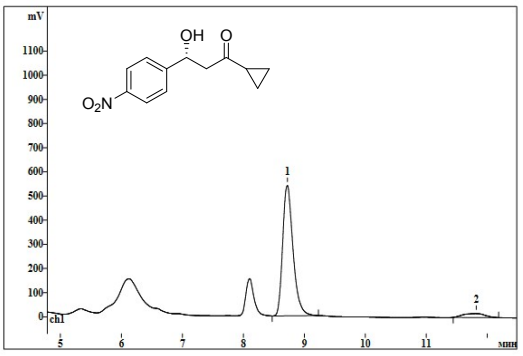



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 16.45 | 14805.46 | 95.77 |
| 2 | 21.61 | 654.51 | 4.23 |
| 2 | 44.79 | 15459.96 | 100.00 |

**(*R*)-1-Cyclopropyl-3-hydroxy-3-(4-nitrophenyl)propan-1-one (10f)**: *Chiralpak OJ-H*, 0.8 mL/min, *n*-hexane/*i*-PrOH = 70:30, λ = 254 nm, $t_{major}$ = 8.7 min, $t_{minor}$ = 11.8 min.

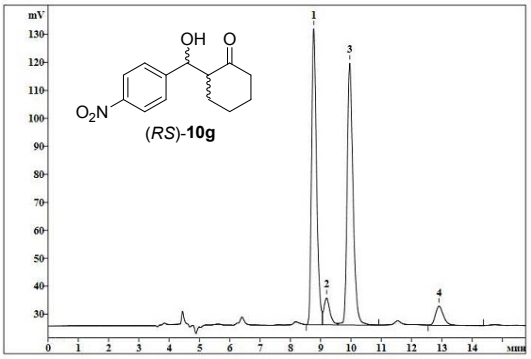



| No | Retention мин | Width/2 мин | Height mV | Height % | Area mV*сек | Area % |
|---|---|---|---|---|---|---|
| 1 | 8.408 | 0.165 | 137.57 | 59.56 | 1500.52 | 51.03 |
| 2 | 11.07 | 0.240 | 93.41 | 40.44 | 1439.80 | 48.97 |
| 2 | 12.16 | 0.203 | 230.98 | 100.00 | 2940.32 | 100.00 |

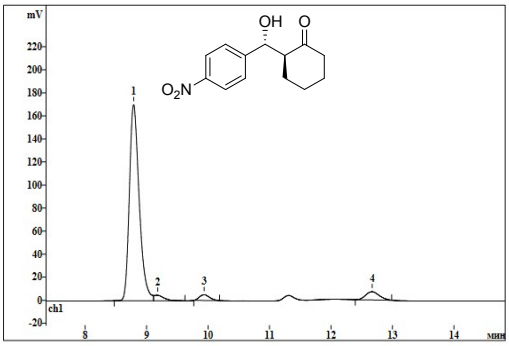



| No | Retention мин | Width/2 мин | Height mV | Height % | Area mV*сек | Area % |
|---|---|---|---|---|---|---|
| 1 | 8.72 | 0.178 | 538.88 | 97.06 | 6370.68 | 94.03 |
| 2 | 11.82 | 0.415 | 16.30 | 2.94 | 404.73 | 5.97 |
| 2 | 12.57 | 0.296 | 555.17 | 100.00 | 6775.42 | 100.00 |

**(*S*)-2-((*R*)-hydroxy(4-nitrophenyl)methyl)cyclohexanone (10g)**: *Chiralpak OJ-H*, 0.8 mL/min, *n*-hexane/*i*-PrOH = 70:30, λ=254 nm, $t_{major}$ = 8.9 min, $t_{minor}$ = 9.5 min.

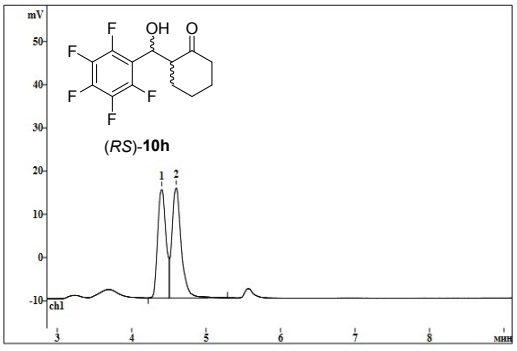



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 8.766 | 1219.78 | 44.64 |
| 2 | 9.193 | 132.97 | 4.87 |
| 3 | 9.956 | 1256.12 | 45.97 |
| 4 | 12.9 | 123.68 | 4.53 |
| 4 | 15.77 | 2732.56 | 100.00 |

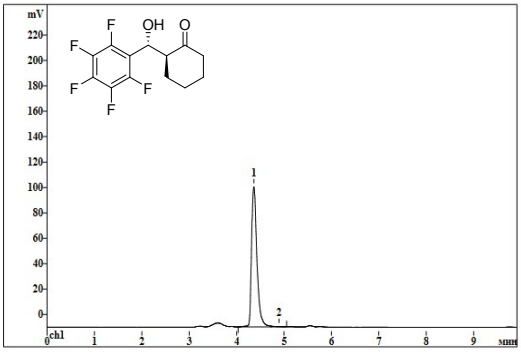



| No | Retention мин | Width/2 мин | Height mV | Height % | Area mV*сек | Area % |
|---|---|---|---|---|---|---|
| 1 | 8.788 | 0.167 | 170.21 | 90.99 | 1892.88 | 89.59 |
| 2 | 9.175 | 0.171 | 4.75 | 2.54 | 53.26 | 2.52 |
| 3 | 9.937 | 0.183 | 4.99 | 2.67 | 57.38 | 2.72 |
| 4 | 12.67 | 0.243 | 7.11 | 3.80 | 109.33 | 5.17 |
| 4 | 44.75 | 0.191 | 187.06 | 100.00 | 2112.85 | 100.00 |

**(*S*)-2-((*R*)-hydroxy(perfluorophenyl)methyl)cyclohexanone (10h)**:*Chiralpak OJ-H*, 1 mL/min, *n*-hexane/*i*-PrOH = 90:10, λ = 254 nm, $t_{major}$ = 4.3 min, $t_{minor}$ = 4.9 min.

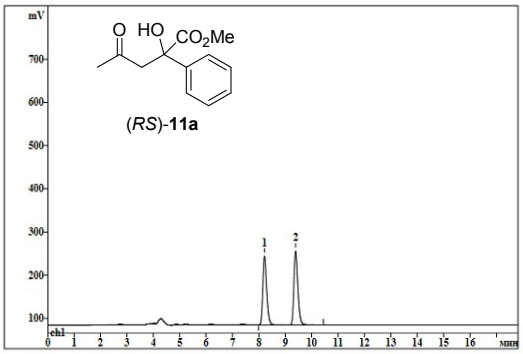



| No | Retention мин | Width/2 мин | Height mV | Height % | Area mV*сек | Area % |
|---|---|---|---|---|---|---|
| 1 | 4.403 | 0.125 | 25.04 | 49.66 | 193.92 | 46.58 |
| 2 | 4.598 | 0.130 | 25.38 | 50.34 | 222.38 | 53.42 |
| 2 | 29.99 | 0.128 | 50.42 | 100.00 | 416.30 | 100.00 |

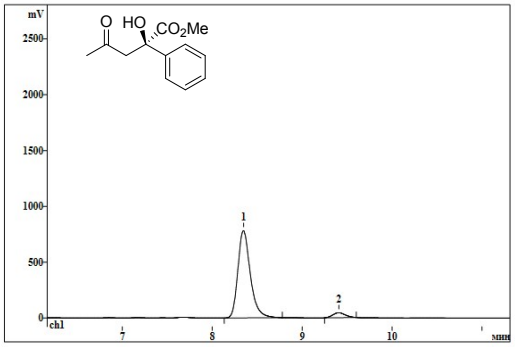



| No | Retention мин | Width/2 мин | Height mV | Height % | Area mV*сек | Area % |
|---|---|---|---|---|---|---|
| 1 | 4.363 | 0.117 | 110.22 | 99.84 | 872.97 | 99.57 |
| 2 | 4.893 | 0.233 | 0.17 | 0.16 | 3.81 | 0.43 |
| 2 | 9.917 | 0.175 | 110.39 | 100.00 | 876.78 | 100.00 |

**(*R*)-Methyl-2-hydroxy-4-oxo-2-phenylpentanoate (11a)**: *Chiralpak AD-H*, 0.7 mL/min, *n*-hexane/*i*-PrOH = 70:30, λ=220 nm, $t_{major}$ = 8.3 min, $t_{minor}$ = 9.4 min.

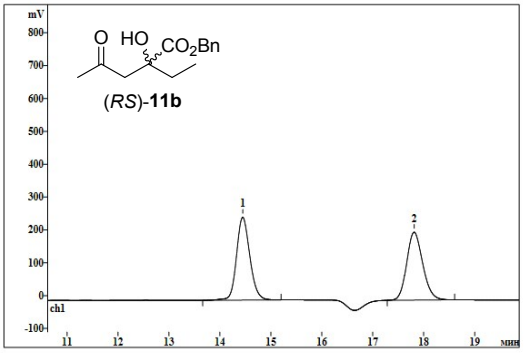



| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 8.376 | 1628.89 | 49.67 |
| 2 | 9.52 | 1650.71 | 50.33 |
| 2 | 16.12 | 3279.60 | 100.00 |

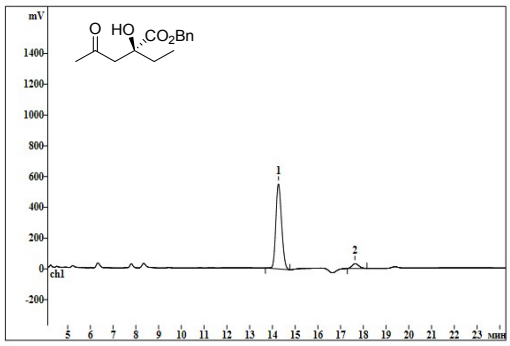



| No | Retention мин | Width/2 мин | Height mV | Height % | Area mV*сек | Area % |
|---|---|---|---|---|---|---|
| 1 | 8.346 | 0.144 | 781.06 | 94.69 | 7516.26 | 94.64 |
| 2 | 9.407 | 0.154 | 43.81 | 5.31 | 425.35 | 5.36 |
| 2 | 15.03 | 0.149 | 824.87 | 100.00 | 7941.61 | 100.00 |

**(*S*)-Benzyl-2-ethyl-2-hydroxy-4-oxopentanoate (11b)**: *Chiralpak AD-H*, 1 mL/min, *n*-hexane/*i*-PrOH = 95:5, λ=210 nm, $t_{major}$ = 14.3 min, $t_{minor}$ = 17.7 min.

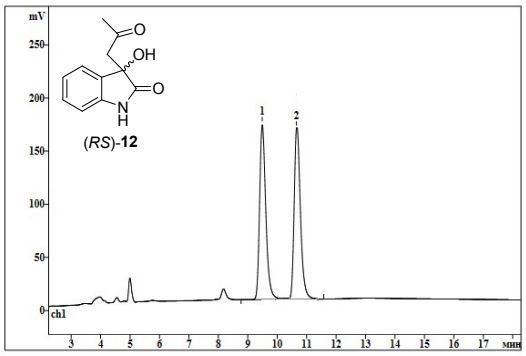



| No | Retention мин | Width/2 мин | Height mV | Height % | Area mV*сек | Area % |
|---|---|---|---|---|---|---|
| 1 | 14.45 | 0.275 | 252.15 | 54.97 | 4580.03 | 50.37 |
| 2 | 17.81 | 0.335 | 206.55 | 45.03 | 4513.28 | 49.63 |
| 2 | 22.62 | 0.305 | 458.70 | 100.00 | 9093.31 | 100.00 |

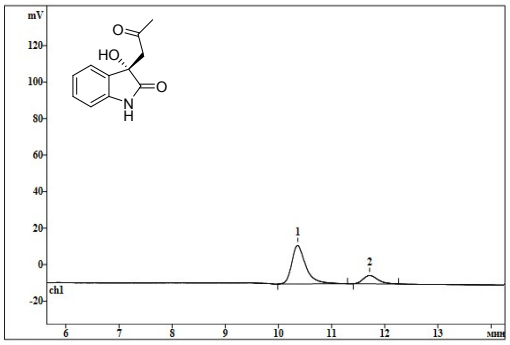



| No | Retention мин | Width/2 мин | Height mV | Height % | Area mV*сек | Area % |
|---|---|---|---|---|---|---|
| 1 | 14.26 | 0.275 | 551.96 | 94.73 | 9743.82 | 93.78 |
| 2 | 17.65 | 0.329 | 30.72 | 5.27 | 646.49 | 6.22 |
| 2 | 44.93 | 0.302 | 582.68 | 100.00 | 10390.31 | 100.00 |

**(*S*)-3-Hydroxy-3-(2-oxopropyl)indolin-2-one (12):***Chiralpak OJ-H*, 0.8 mL/min, *n*-hexane/*i*-PrOH = 70:30, λ = 254 nm, $t_{major}$ = 10.4 min, $t_{minor}$ = 11.7 min.

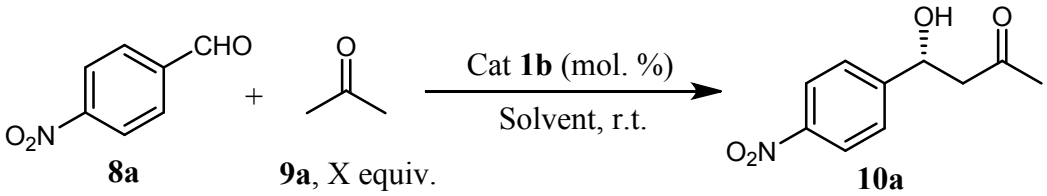



| No | Retention мин | Area % |
|---|---|---|
| 1 | 9.489 | 50.16 |
| 2 | 10.87 | 49.84 |




| No | Retention мин | Area mV*сек | Area % |
|---|---|---|---|
| 1 | 10.36 | 380.38 | 81.74 |
| 2 | 11.71 | 87.21 | 18.26 |
| 2 | 54.77 | 477.59 | 100.00 |

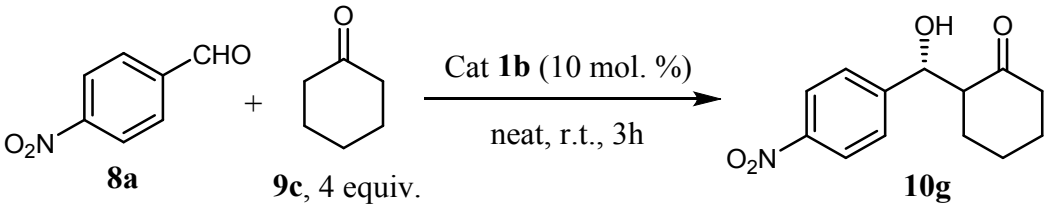
Table 1. Optimization of catalyst structure and reaction conditions.[a]



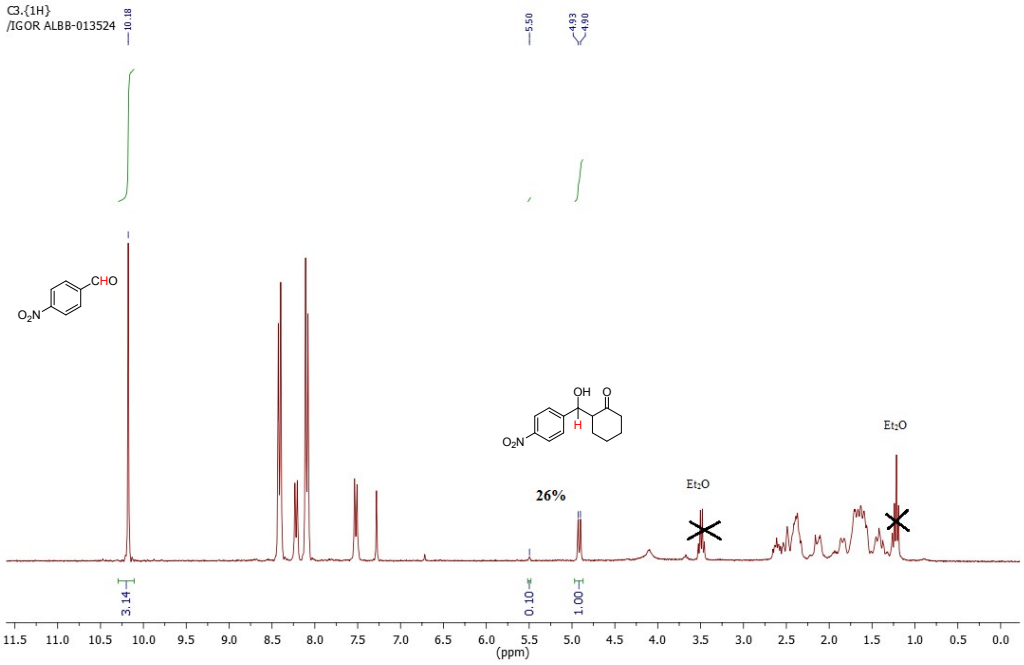

**8a** **9a**, X equiv. **10a**

| Entry | Cat (mol. %) | Solvent | X equiv. | T, h | Yield, **10** % | *ee*, % |
|---|---|---|---|---|---|---|
| 1 | (*R,S*)-**1b** (10) | neat | 4 | 25 | 94 | 91 |
| 2 | (*R,R*)-**1b** (10) | neat | 4 | 25 | 85 | 86 |
| 3 | (*R,S*)-**1b** (10) | DCM | 4 | 25 | 25 | 81 |
| 4 | (*R,S*)-**1b** (10) | THF | 4 | 25 | 20 | 80 |
| 5 | (*R,S*)-**1b** (10) | IPS | 4 | 25 | 48 | 82 |
| 6 | (*R,S*)-**1b** (10) | PhMe | 4 | 25 | <10 | n.d. |
| 7 | (*R,S*)-**1b** (10) | EtOAc | 4 | 25 | 15 | 77 |
| 8 | (*R,S*)-**1b** (5) | neat | 4 | 25 | 85 | 86 |
| 9 | (*R,S*)-**1b** (10) | neat | 2 | 30 | 72 | 87 |

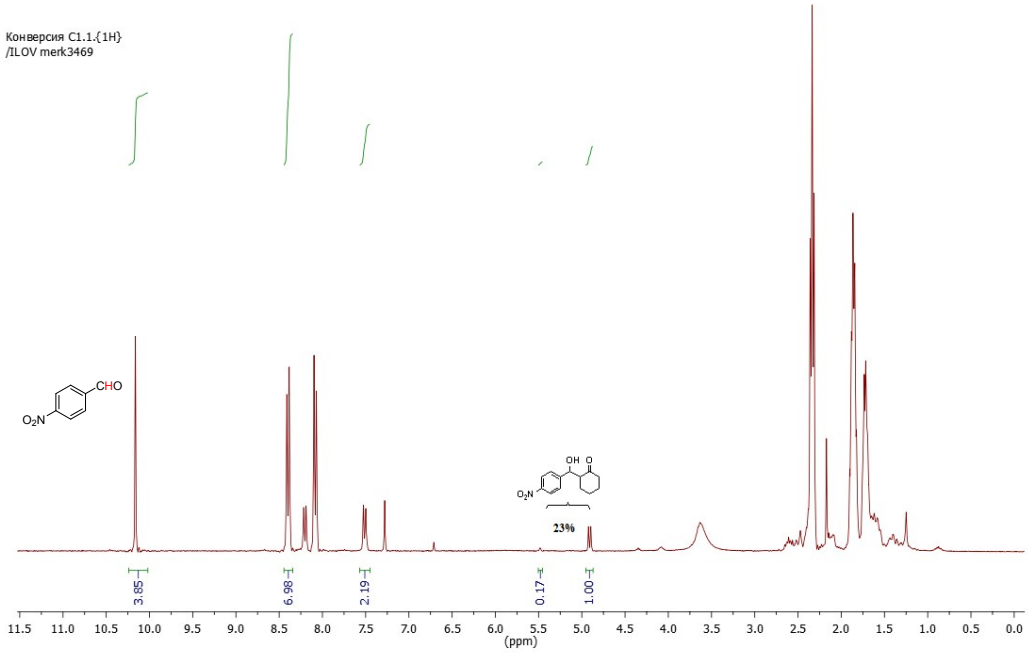
[a]The reactions were carried out with catalysts **1b** (5–10 mol%), 4-nitrobenzaldehyde **8a** (0.52 mol, 78.5 mg), acetone **9a** (2–4 equiv, 76.0 - 152 μL) and solvent (100 μL) (if applicable) at r.t.




**Spectra $^1$H NMR of the reaction mixture in the presence of fresh sample of 1b measured at 3 h time period.**




**Spectra $^1$H NMR of the reaction mixture in the presence of 15-fold used sample of 1b measured at 3 h time period.**



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