

Supporting Information

**Highly Enantioselective Michael Addition Reactions with New
Trimeric Chiral Phase Transfer Catalysts**

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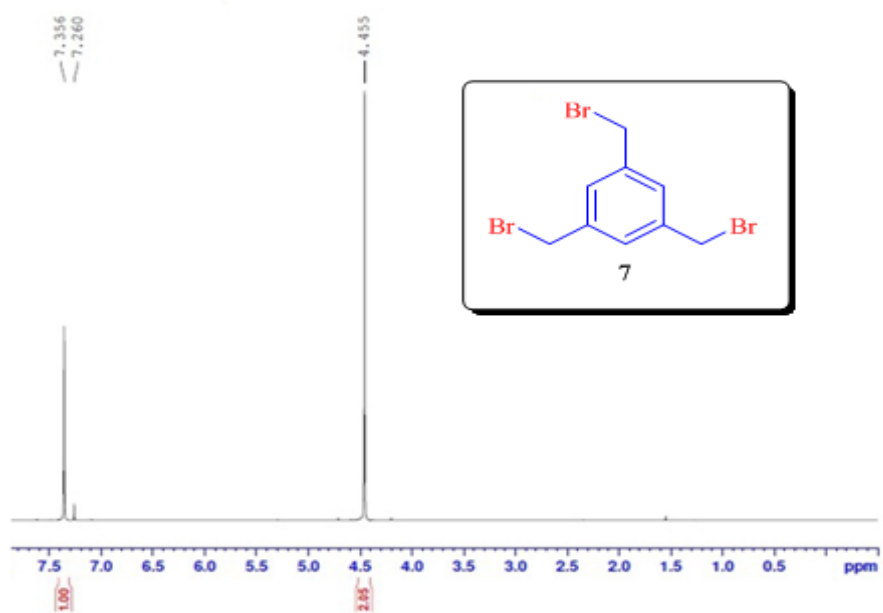


Figure S1. ¹H NMR Spectrum of 1, 3, 5-tribromomesitylene (7).

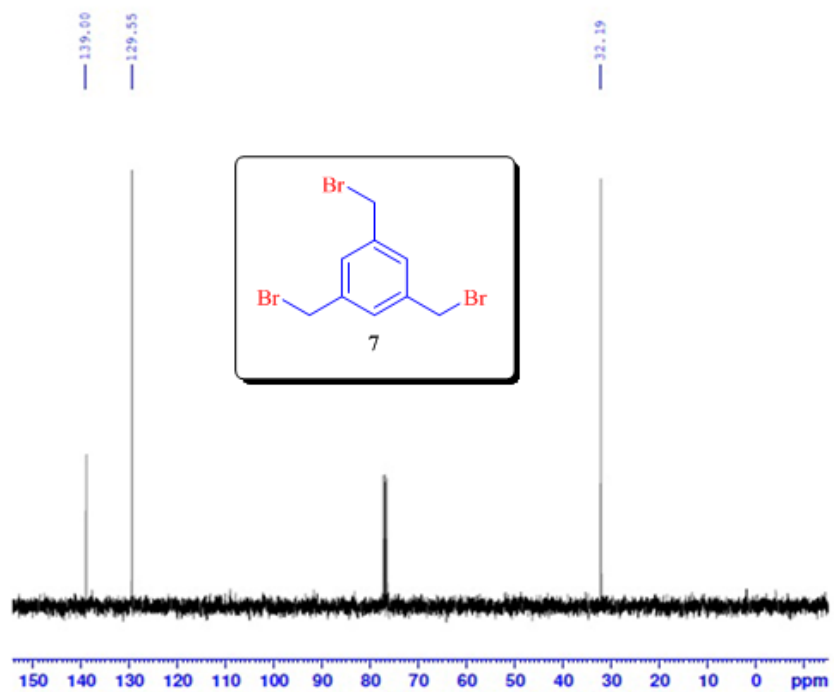


Figure S2. ¹³C NMR Spectrum of 1, 3, 5-tribromomesitylene (7).

Supporting Information

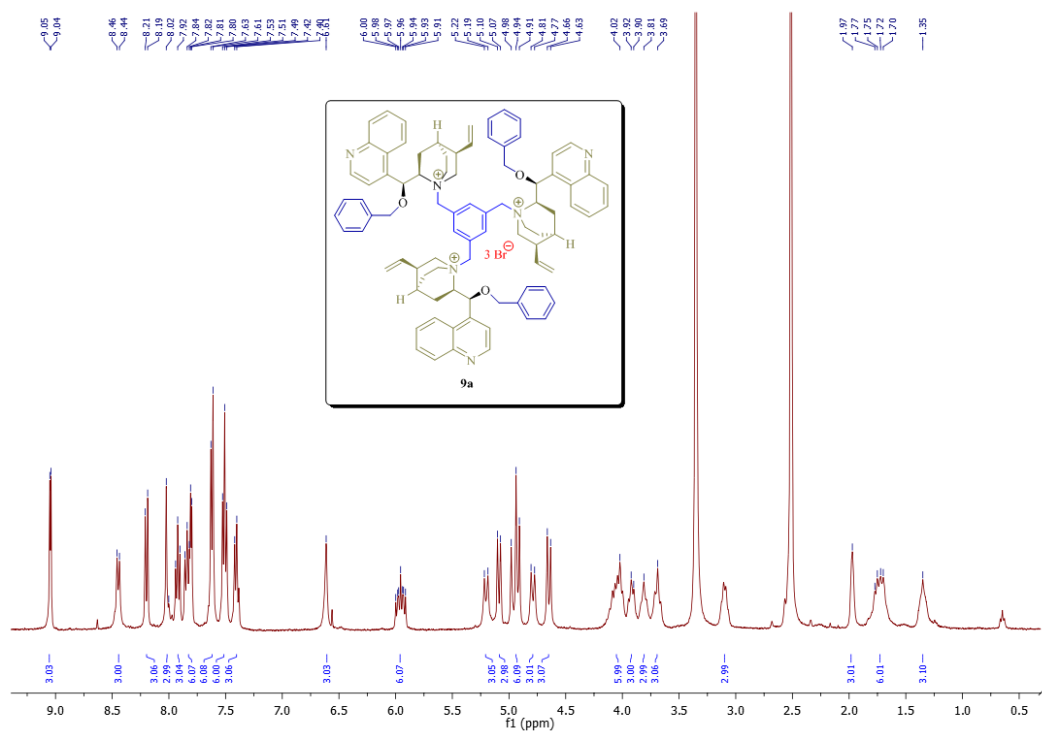


Figure S3. ^1H NMR Spectrum of Mesitylene based benzylcinchonine (9a).

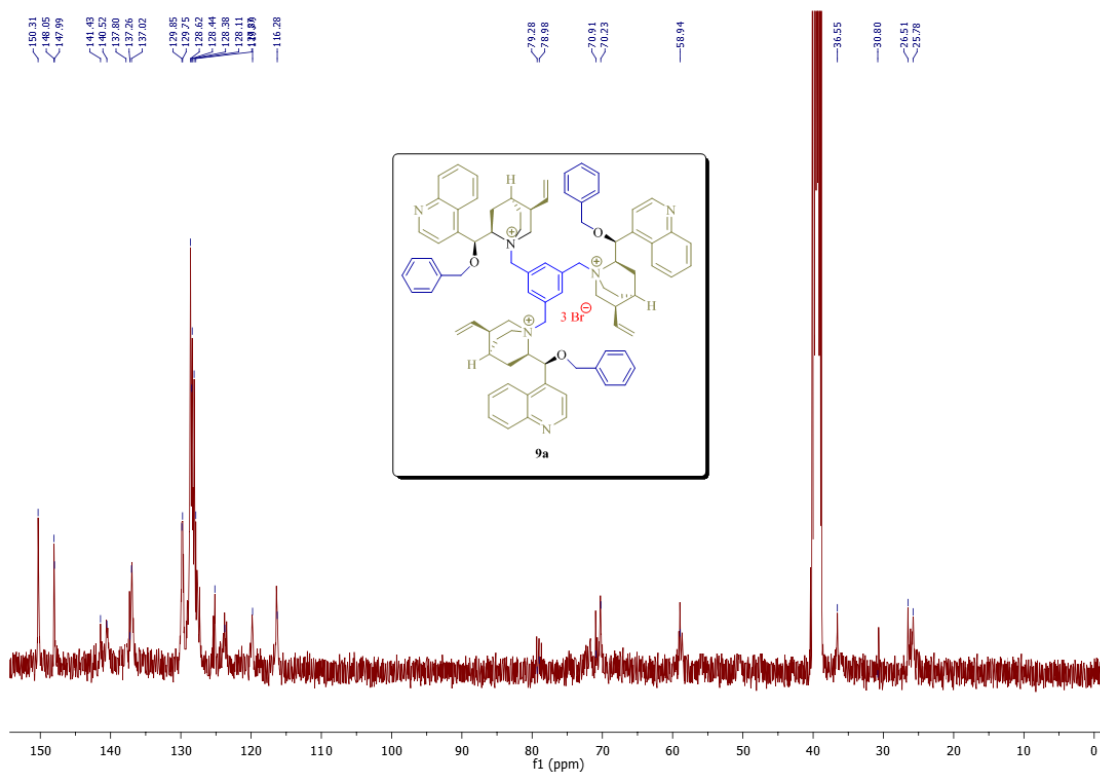


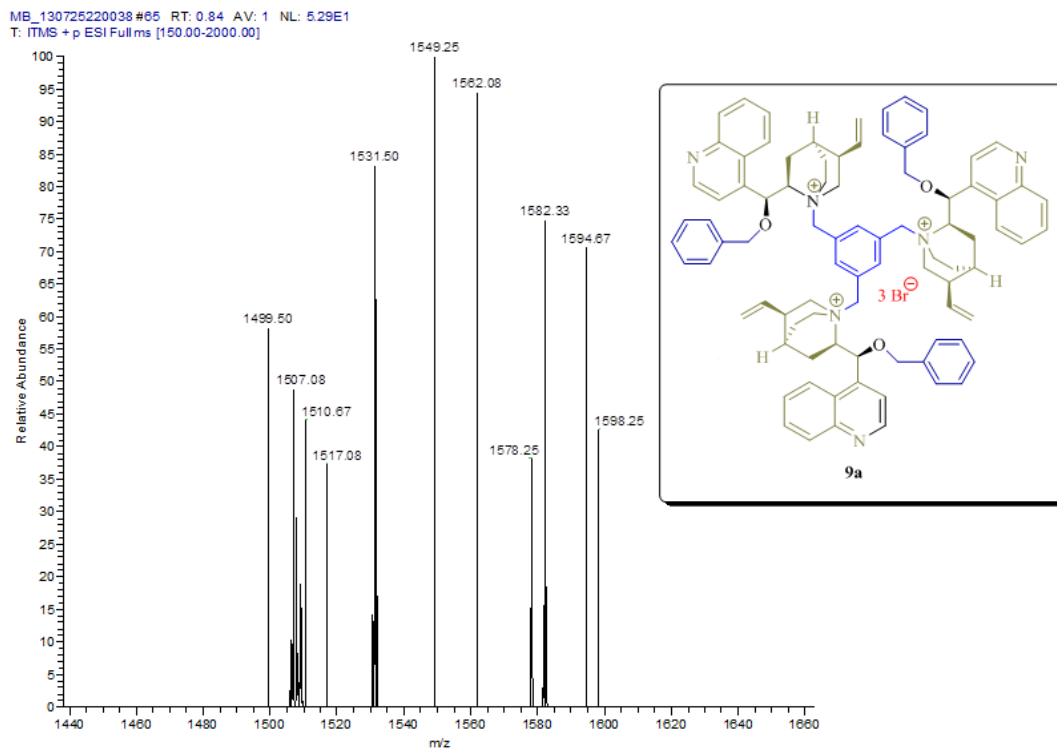
Figure S4. C^{13} NMR Spectrum of Mesitylene based benzylcinchonine (9a).

Figure S5. ESI - Mass Spectrum of Mesitylene based benzylcinchonine (9a).

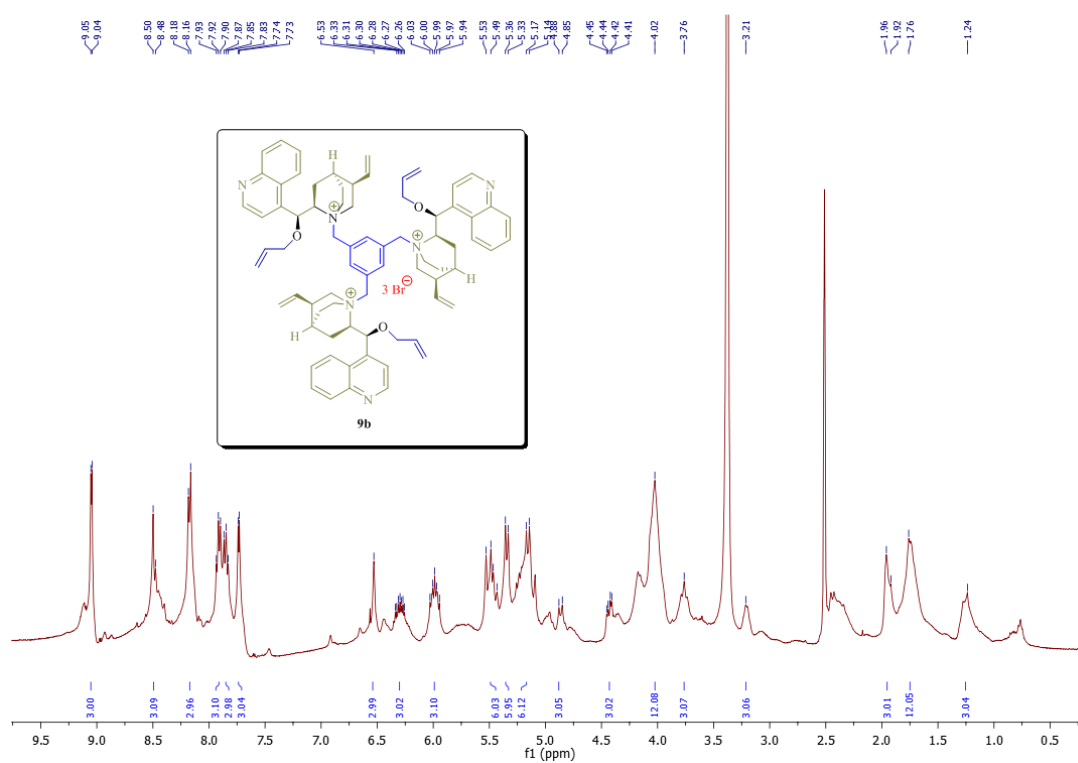


Figure S6. ^1H NMR Spectrum of Mesitylene based allylcinchonine (9b).

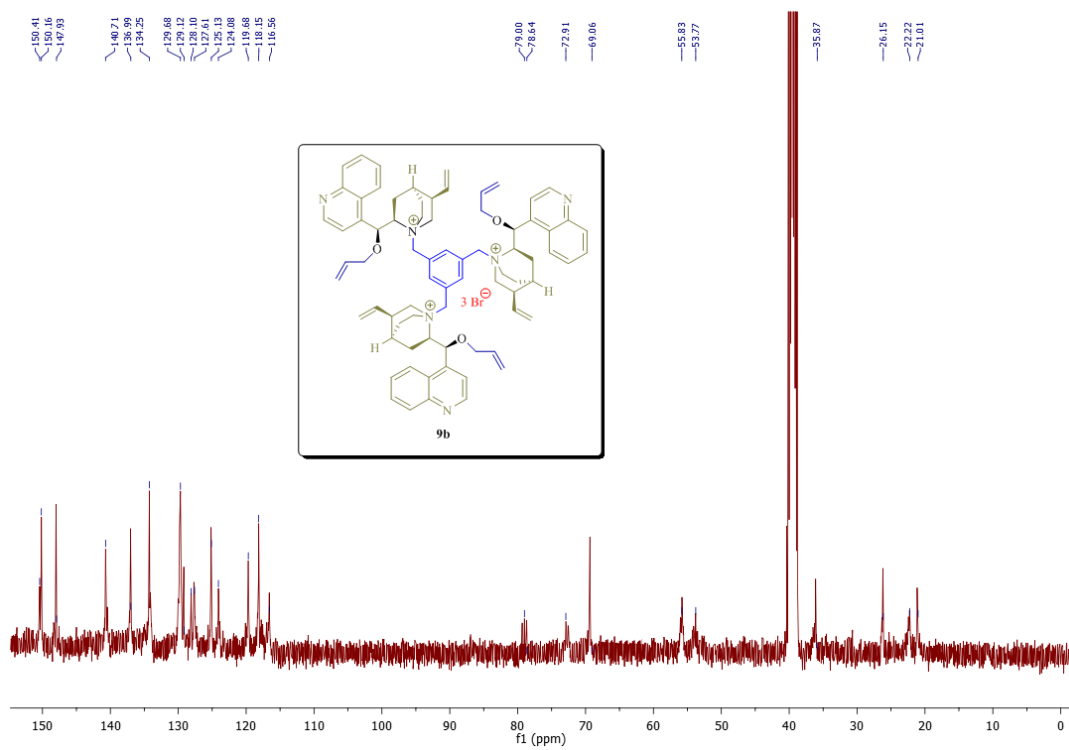


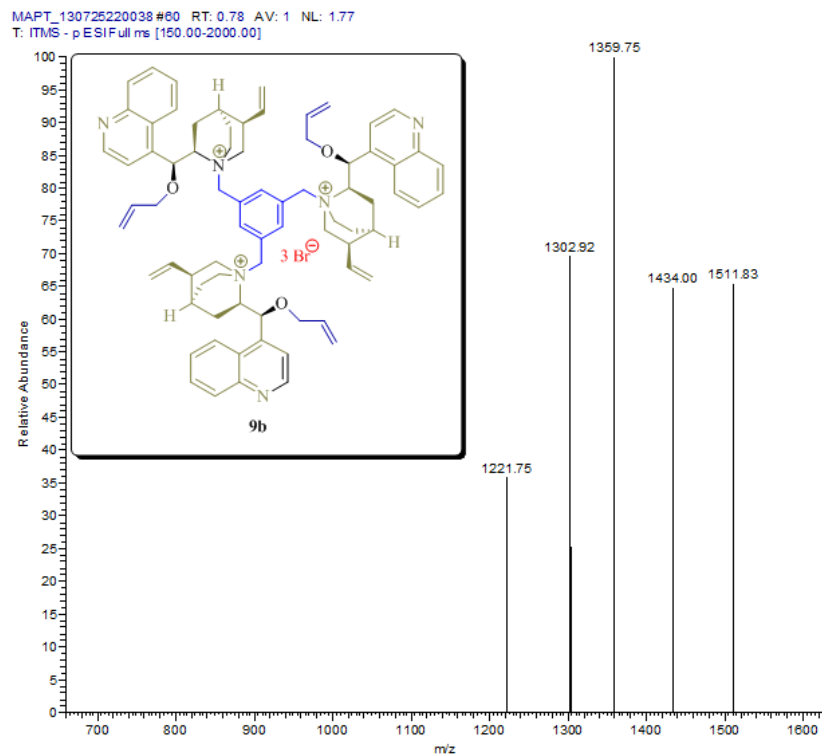
Figure S7. C^{13} NMR Spectrum of Mesitylene based allylcinchonine (9b).

Figure S8. ESI - Mass Spectrum of Mesitylene based allylcinchonine (9b).

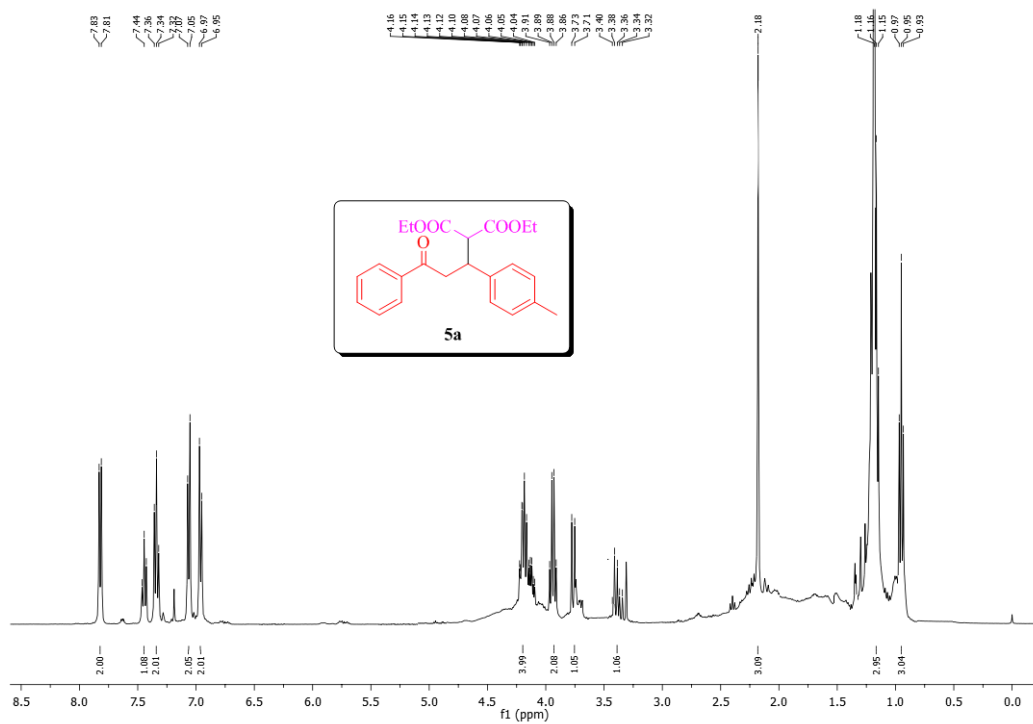


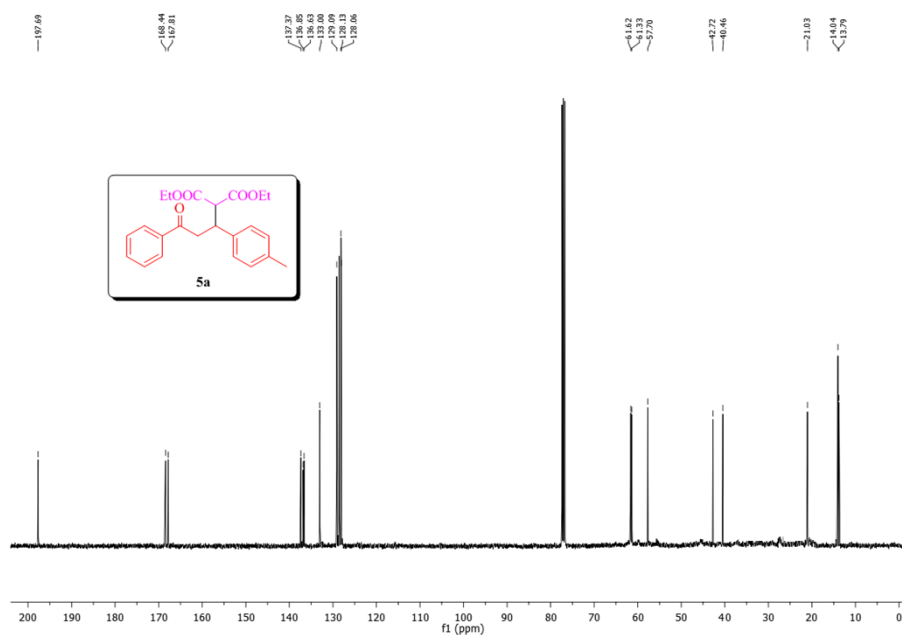
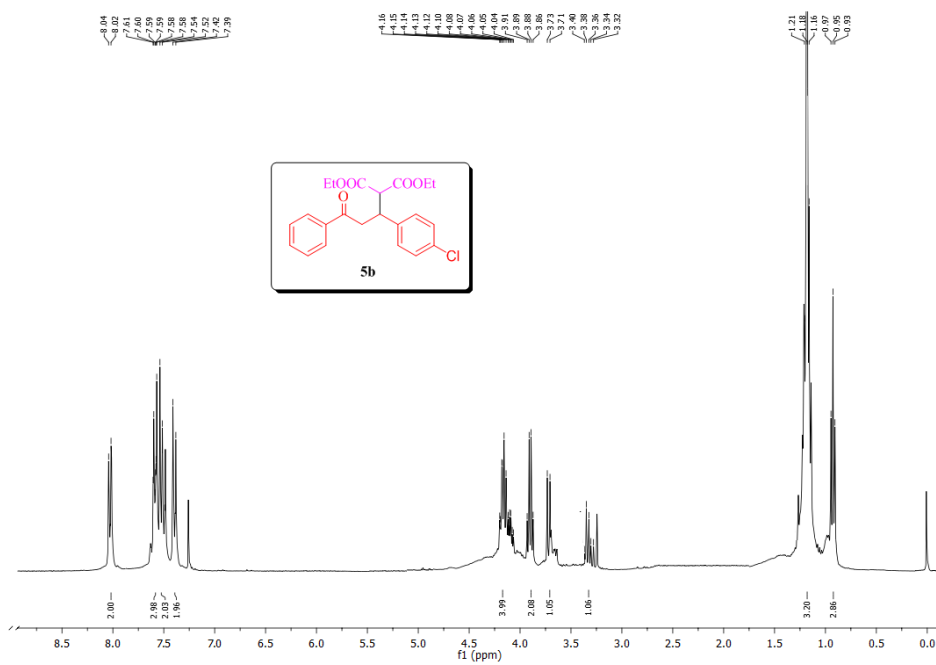
Figure S9. ^1H NMR Spectrum of diethyl 2-(3-oxo-3-phenyl-1-*p*-tolylpropyl) malonate (5a).Figure S10. ^{13}C NMR Spectrum of diethyl 2-(3-oxo-3-phenyl-1-*p*-tolylpropyl) malonate (5a).

Figure S11. ^1H NMR Spectrum of diethyl 2-(1-(4-chlorophenyl)-3-oxo-3-phenylpropyl)malonate (**5b**).

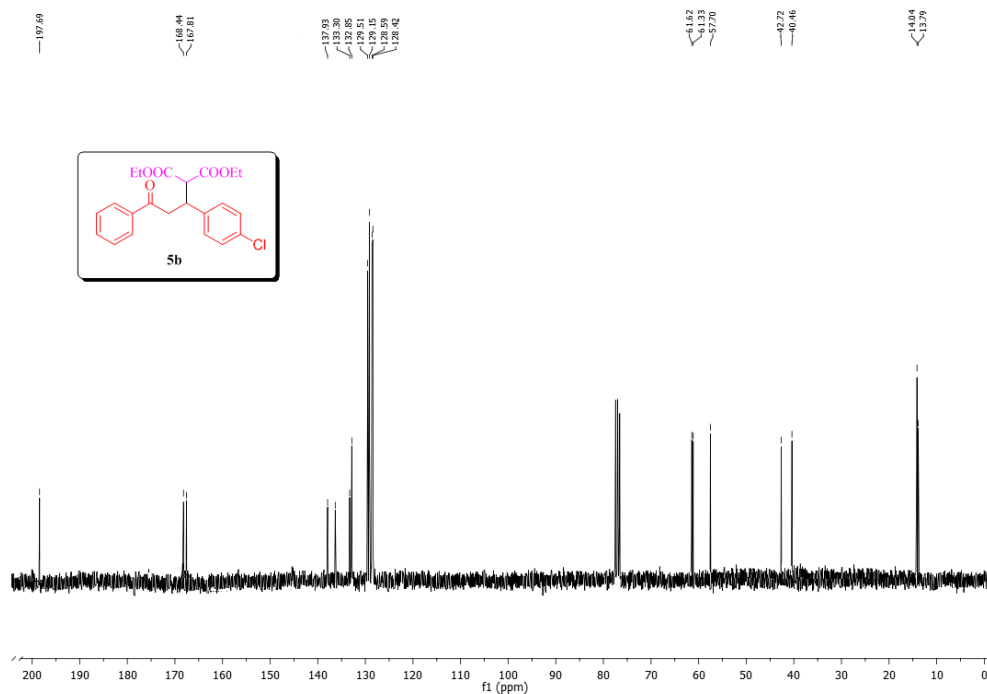


Figure S12. ^{13}C NMR Spectrum of diethyl 2-(1-(4-chlorophenyl)-3-oxo-3-phenylpropyl)malonate (**5b**).

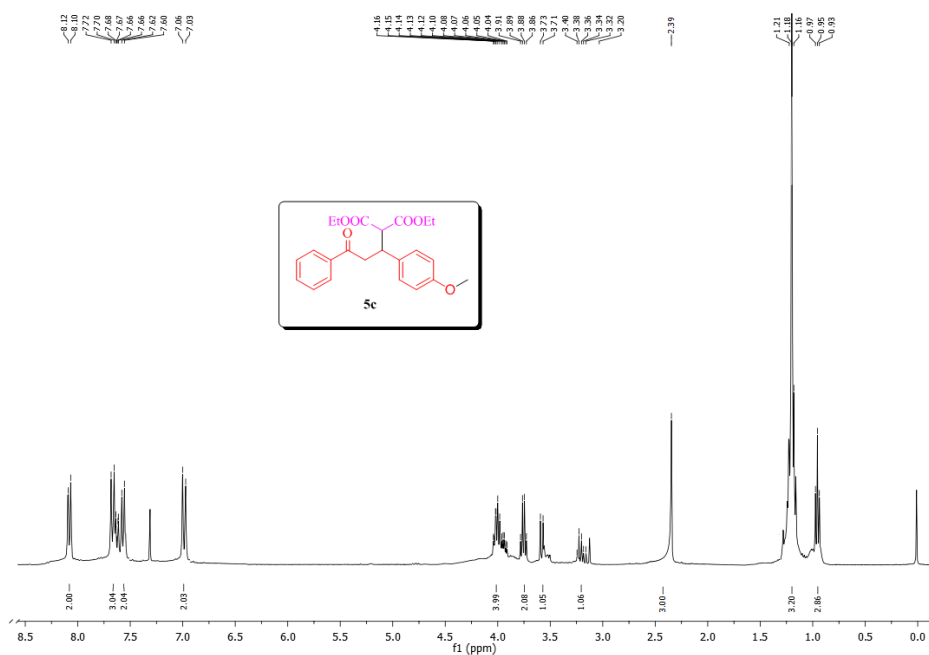


Figure S13. ^1H NMR Spectrum of diethyl 2-(1-(4-methoxyphenyl)-3-oxo-3-phenylpropyl)malonate (5c).

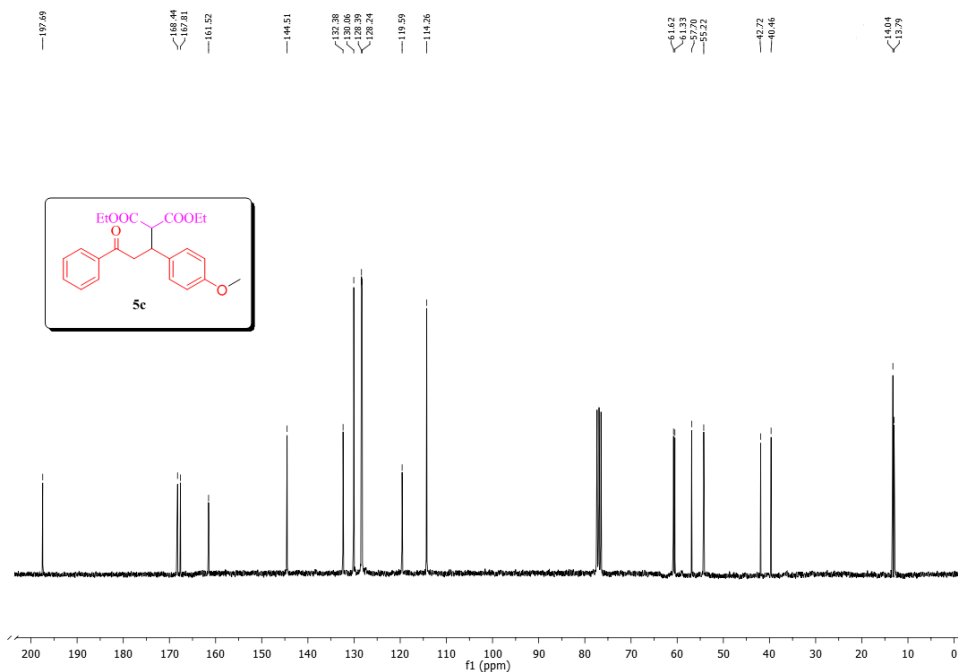


Figure S14. ^{13}C NMR Spectrum of diethyl 2-(1-(4-nitrophenyl)-3-oxo-3-phenylpropyl)malonate (5d).

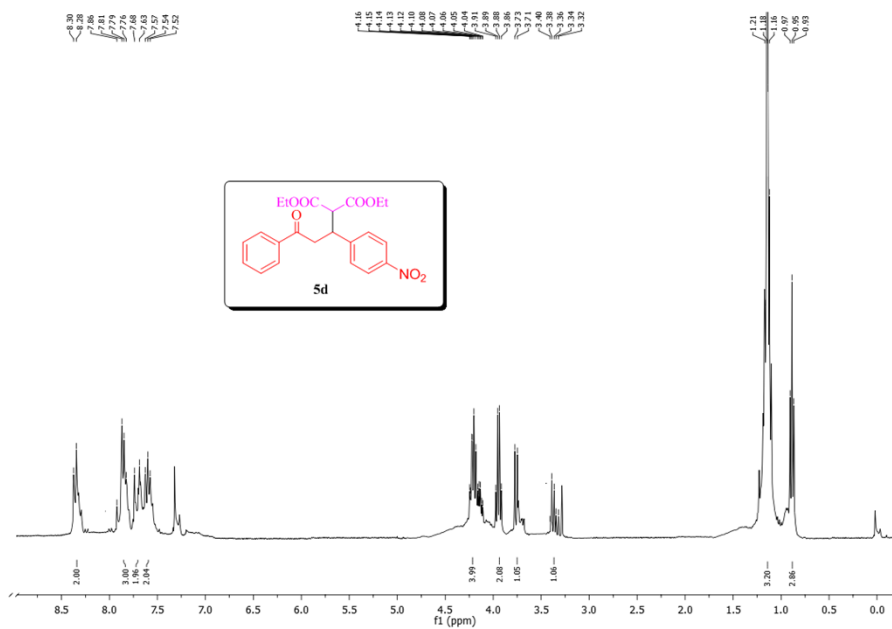


Figure S15. ¹H NMR Spectrum of diethyl 2-(1-(4-nitrophenyl)-3-oxo-3-phenylpropyl)malonate (5d).

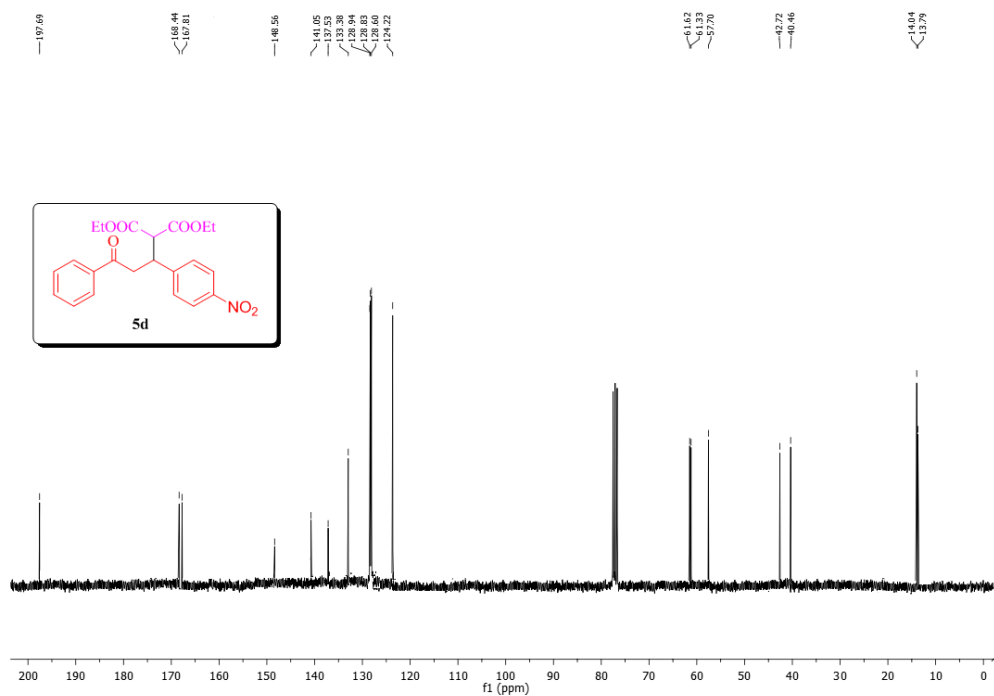


Figure S16. ¹³C NMR Spectrum of diethyl 2-(1-(4-nitrophenyl)-3-oxo-3-phenylpropyl)malonate (5d).

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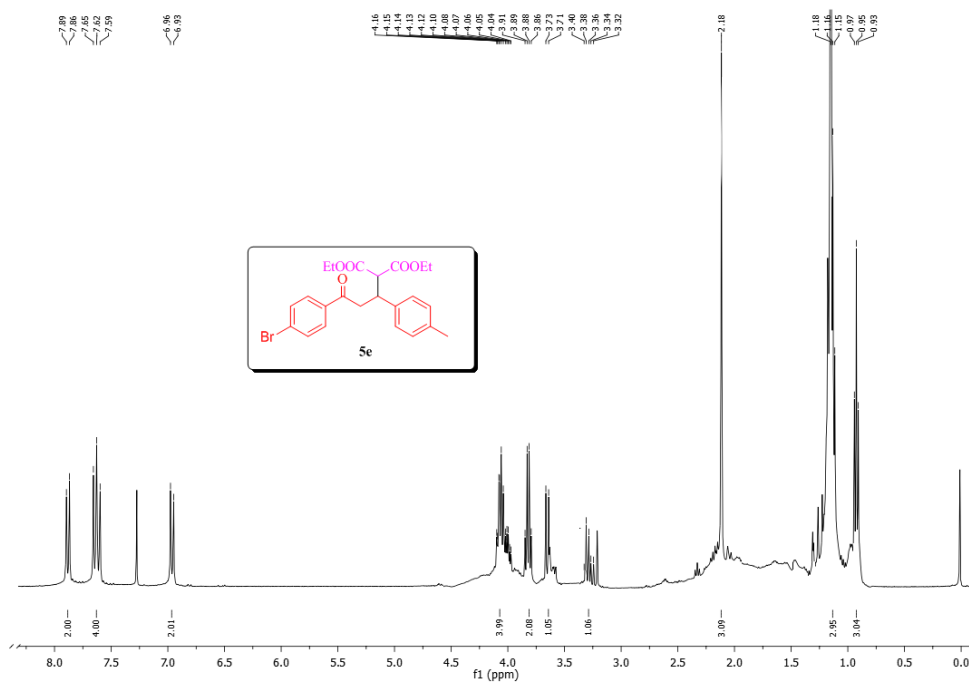


Figure S17. ¹H NMR Spectrum of diethyl 2-(3-(4-bromophenyl)-3-oxo-1-*p*-tolylpropyl)malonate (5e).

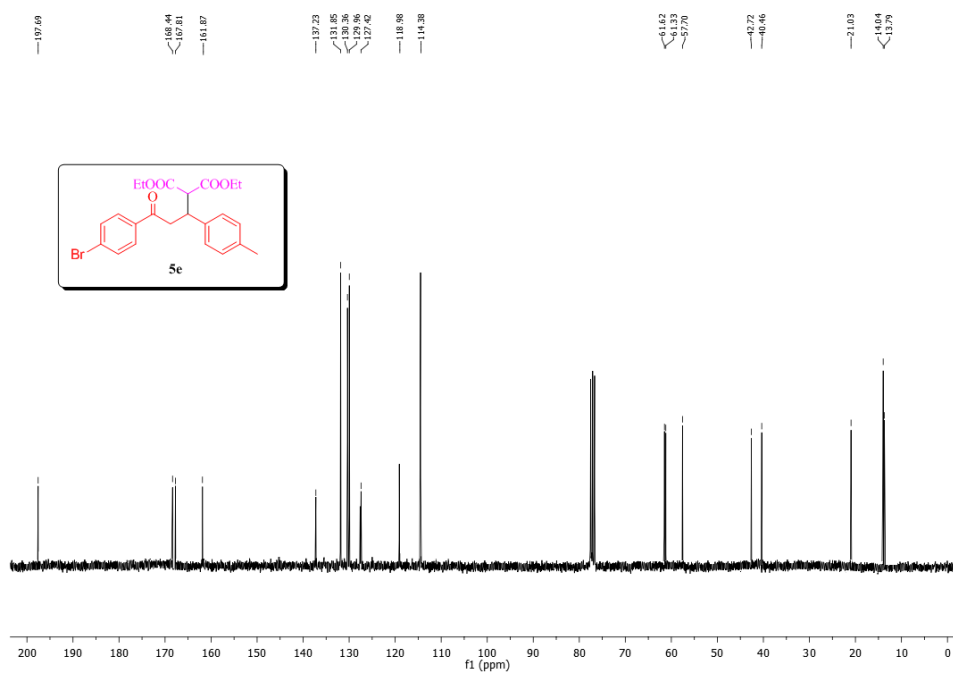


Figure S18. ^{13}C NMR Spectrum of diethyl 2-(3-(4-bromophenyl)-3-oxo-1-*p*-tolylpropyl)malonate (5e).

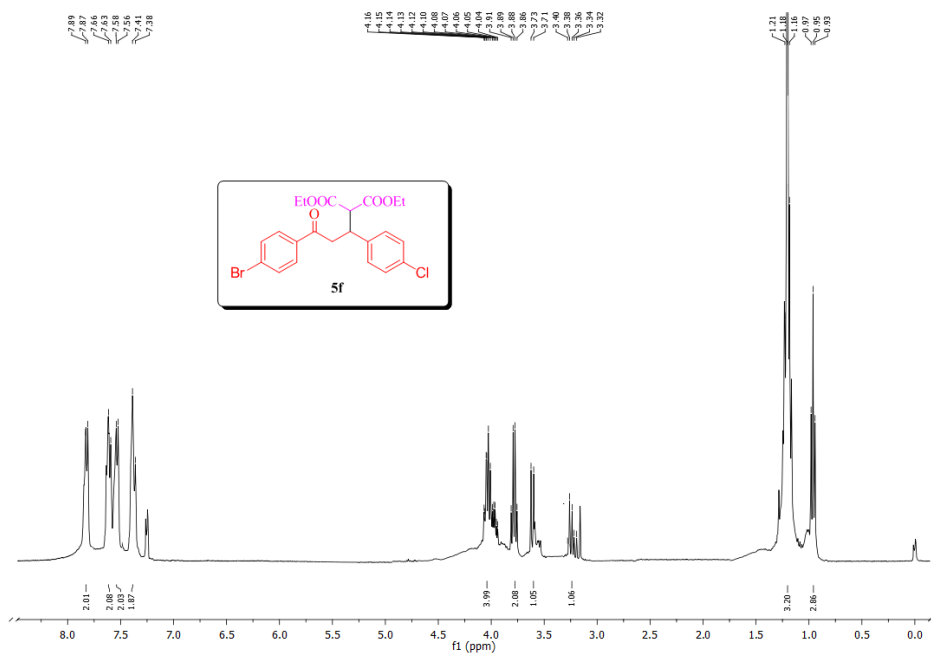


Figure S19. ^1H NMR Spectrum of diethyl 2-(3-(4-bromophenyl)-1-(4-chlorophenyl)-3-oxopropyl)malonate (5f).

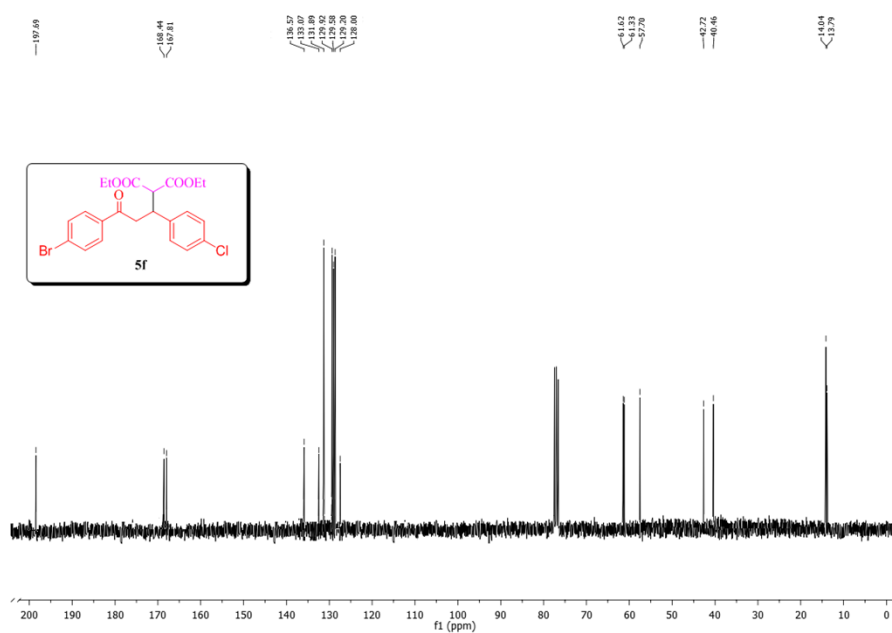


Figure S20. ^{13}C NMR Spectrum of diethyl 2-(3-(4-bromophenyl)-1-(4-chlorophenyl)-3-oxopropyl)malonate (5f).

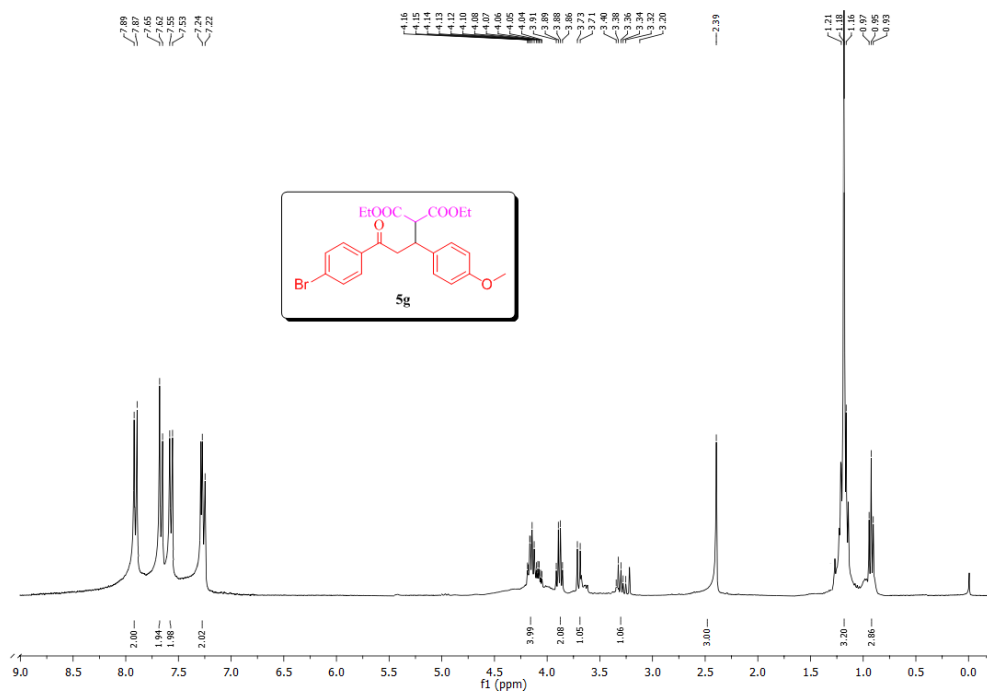


Figure S21. ^1H NMR Spectrum of diethyl 2-(3-(4-bromophenyl)-1-(4-methoxyphenyl)-3-oxopropyl)malonate (5g).

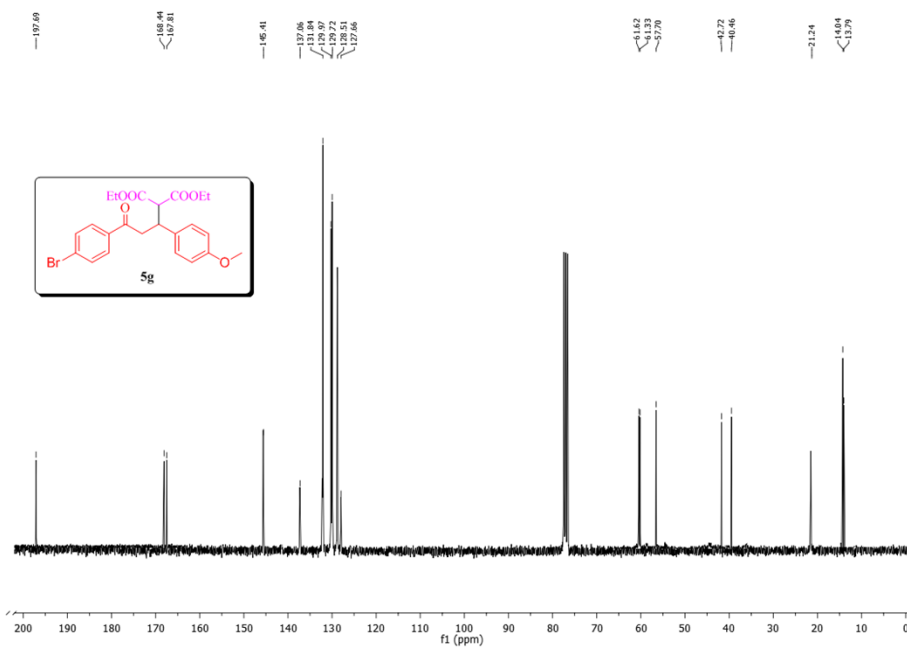


Figure S22. ^{13}C NMR Spectrum of diethyl 2-(3-(4-bromophenyl)-1-(4-methoxyphenyl)-3-oxopropyl)malonate (5g).

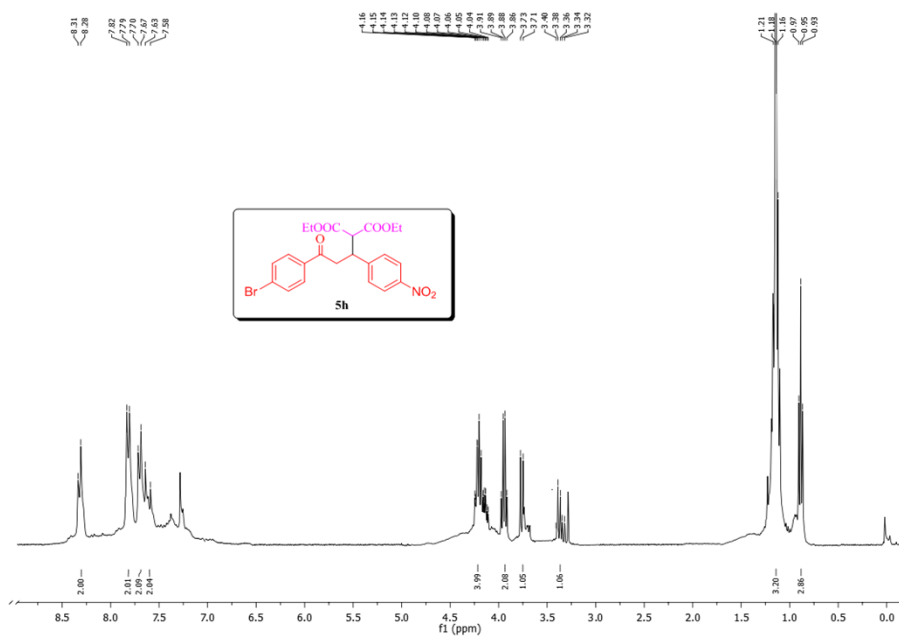


Figure S23. ^1H NMR Spectrum of diethyl 2-(3-(4-bromophenyl)-1-(4-nitrophenyl)-3-oxopropyl)malonate (5h).

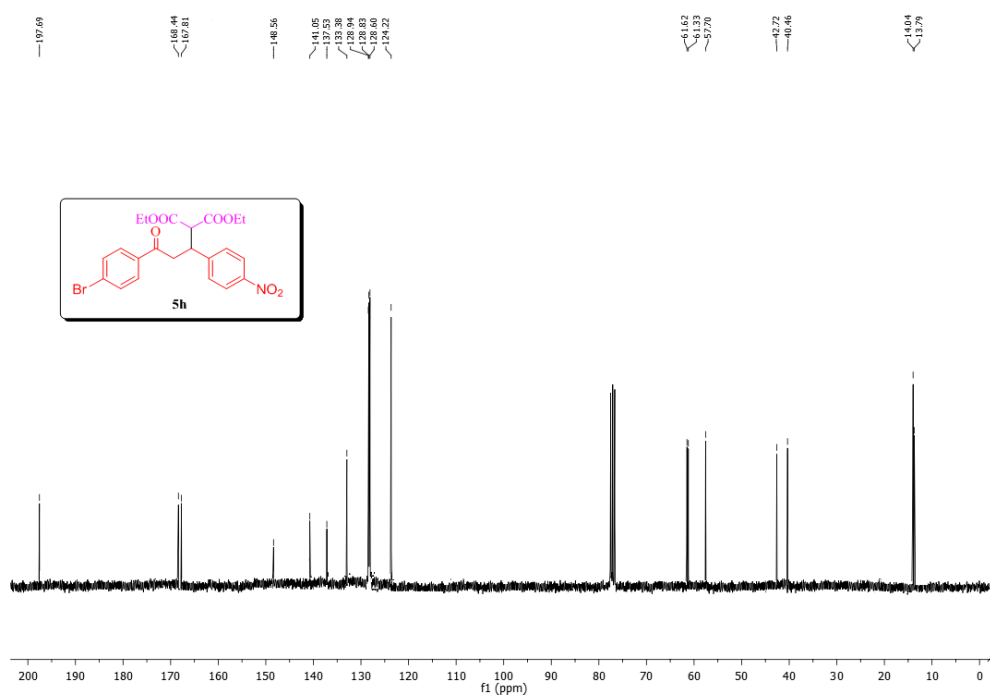
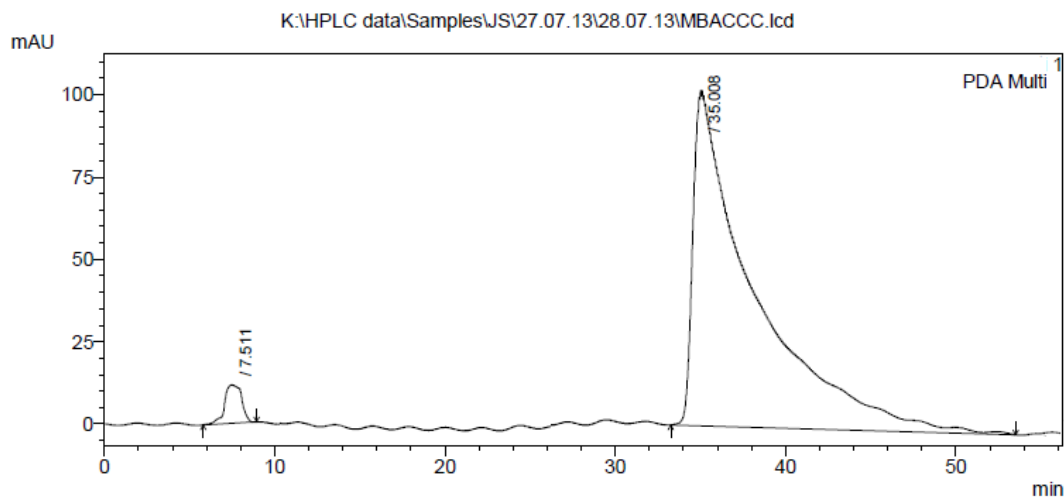


Figure S24. ^{13}C NMR Spectrum of diethyl 2-(3-(4-bromophenyl)-1-(4-nitrophenyl)-3-oxopropyl)malonate (5h).

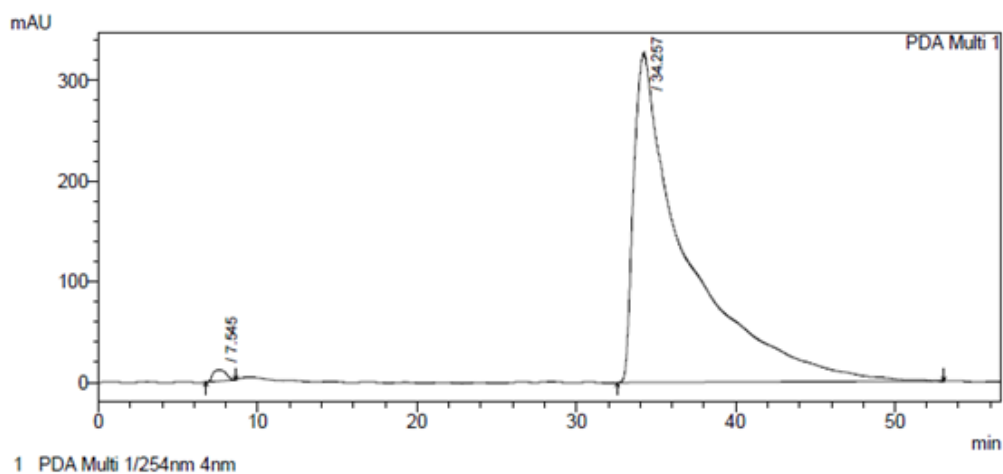


PeakTable

PDA Ch1 254nm 4nm

Name	Peak#	Ret. Time	Area	Height	Area %	Height %
	1	7.511	802355	11645	3.107	10.267
	2	35.008	25024294	101775	96.893	89.733
	Total		25826649	113420	100.000	100.000

Figure S25. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9a) and Toluene/ K_2CO_3 condition.

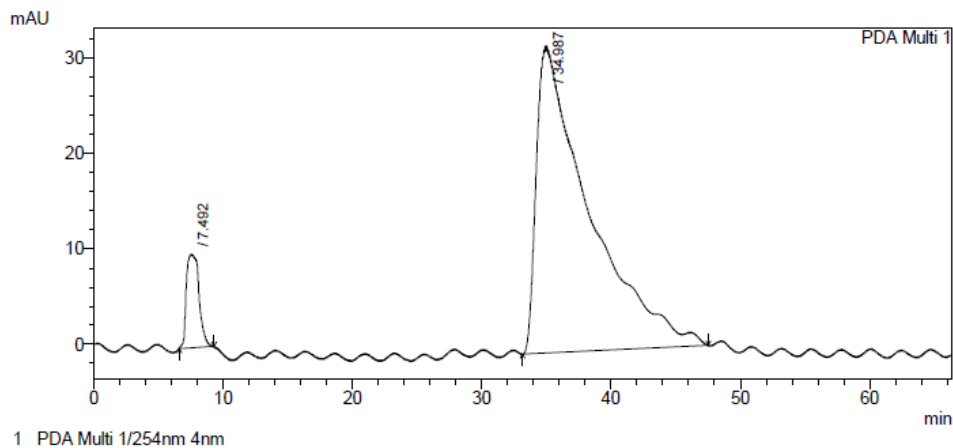


PeakTable

PDA Ch1 254nm 4nm

Name	Peak#	Ret. Time	Area	Height	Area %	Height %
	1	7.545	638607	10978	0.834	3.228
	2	34.257	75973037	329078	99.166	96.772
	Total		76611645	340056	100.000	100.000

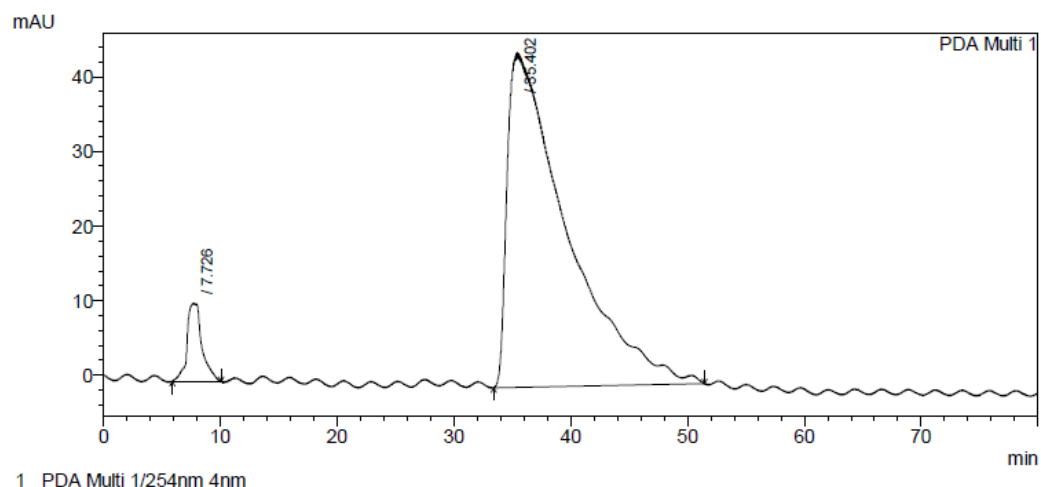
Figure S26. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9b) and Toluene/K₂CO₃ condition.



PeakTable

Name	Peak#	Ret. Time	Area	Height	Area %	Height %
	1	7.492	660684	9806	6.790	23.376
	2	34.987	9070046	32142	93.210	76.624
	Total		9730730	41948	100.000	100.000

Figure S27. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9a) and Toluene/Cs₂CO₃ condition.



PeakTable

Name	Peak#	Ret. Time	Area	Height	Area %	Height %
	1	7.726	921963	10464	5.501	18.895
	2	35.402	15838988	44918	94.499	81.105
	Total		16760951	55382	100.000	100.000

Figure S28. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9b) and Toluene/Cs₂CO₃ condition.

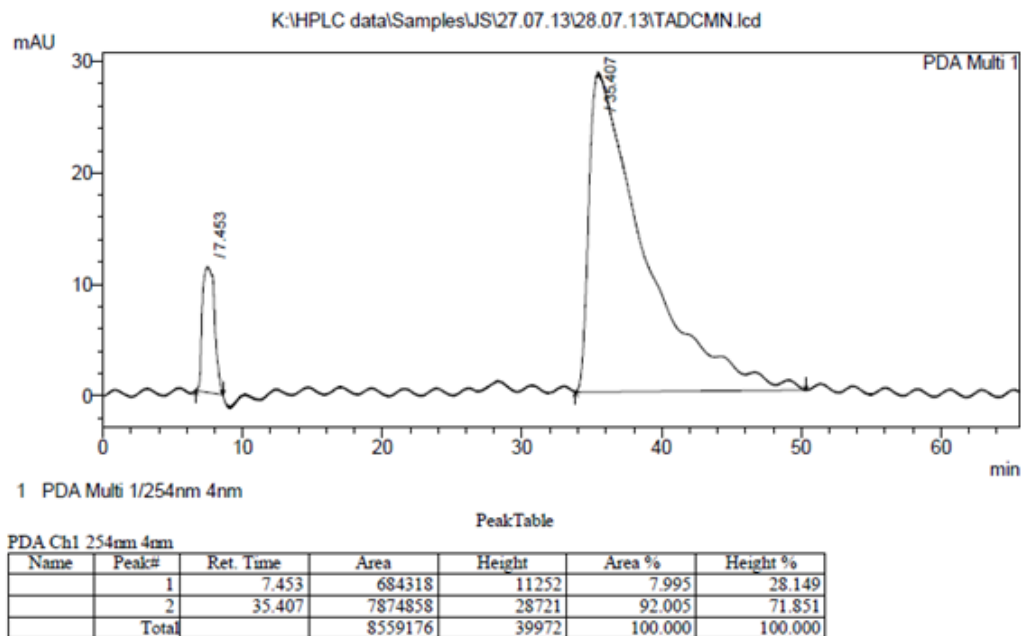


Figure S29. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9a) and Toluene/NaOH condition.

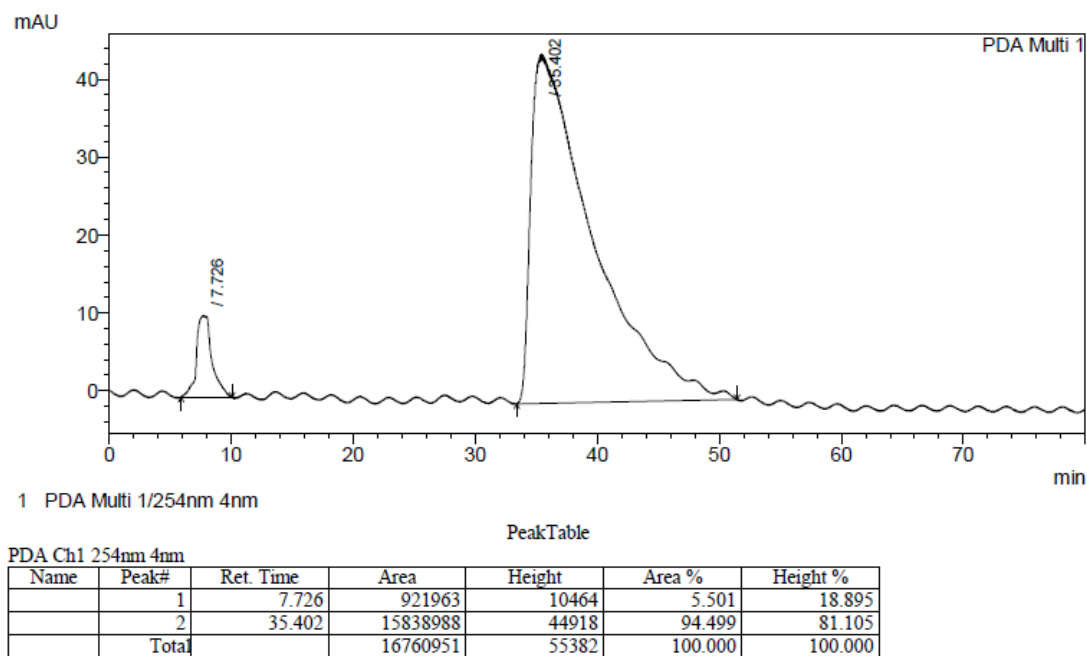


Figure S30. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9b) and Toluene/NaOH condition.

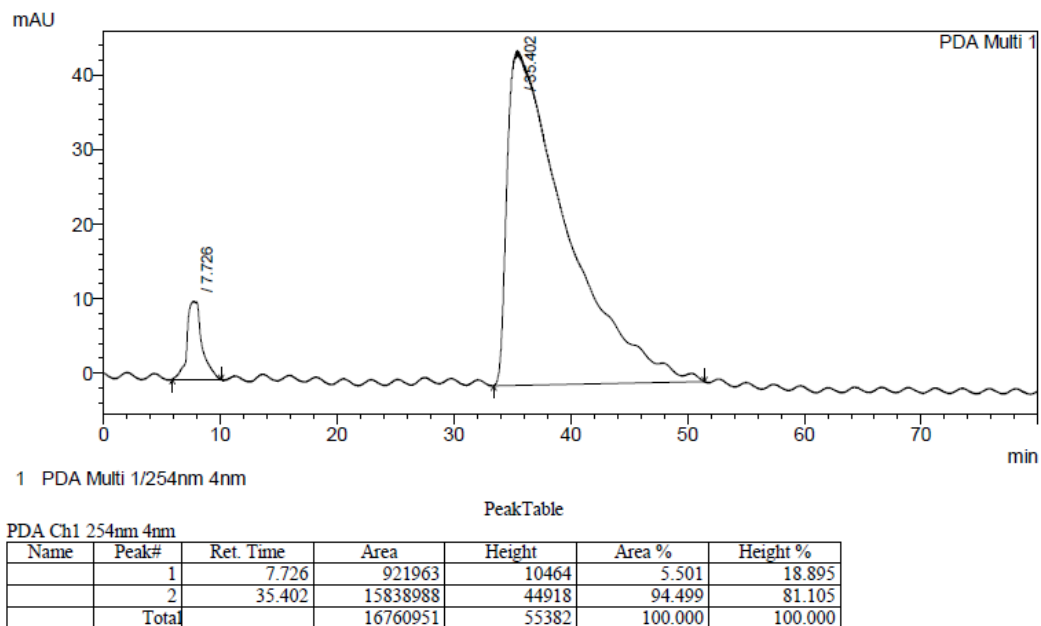


Figure S31. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9a) and Toluene/KOH condition.

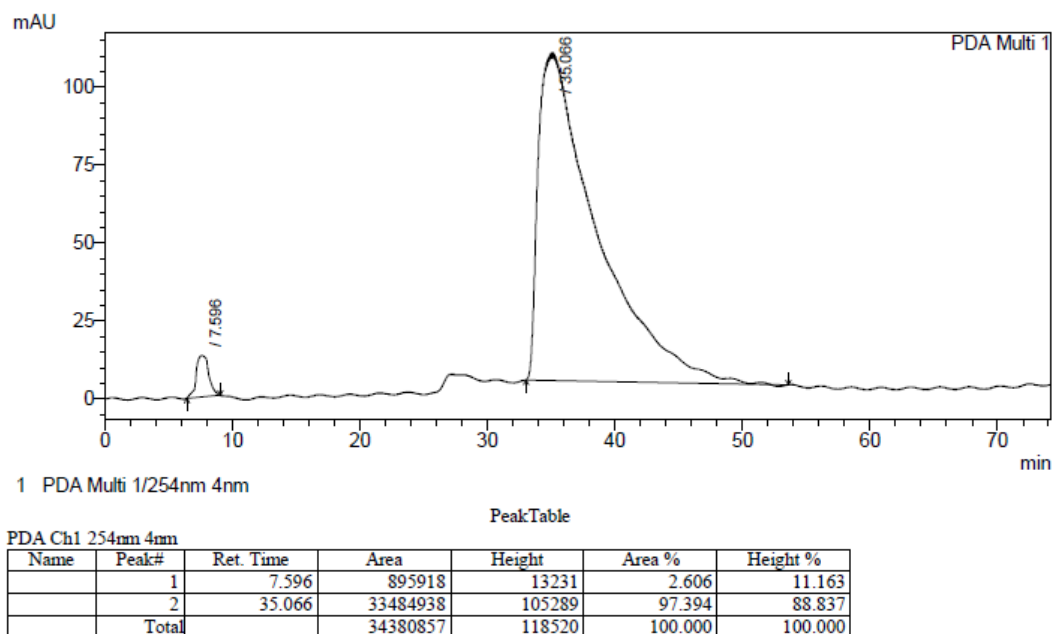
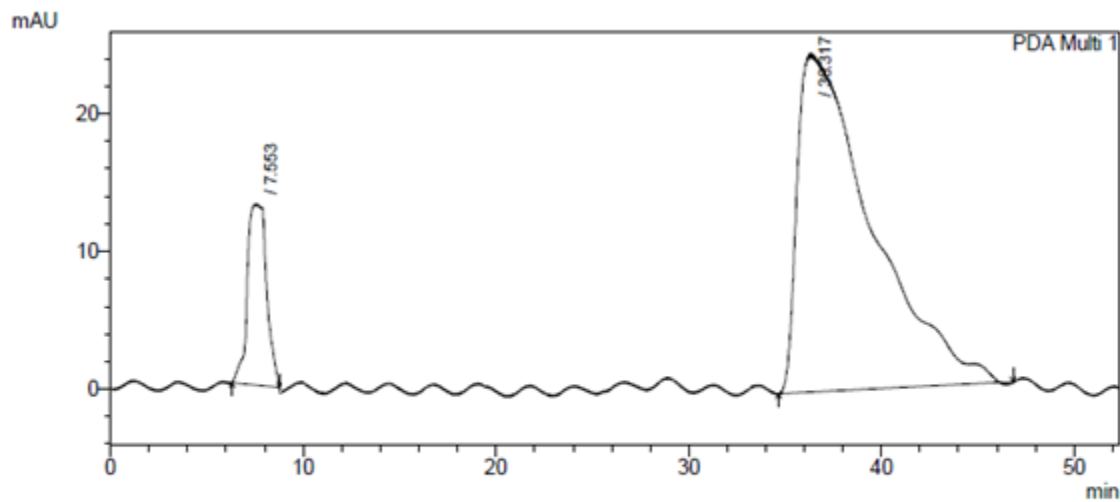


Figure S32. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9b) and Toluene/KOH condition.

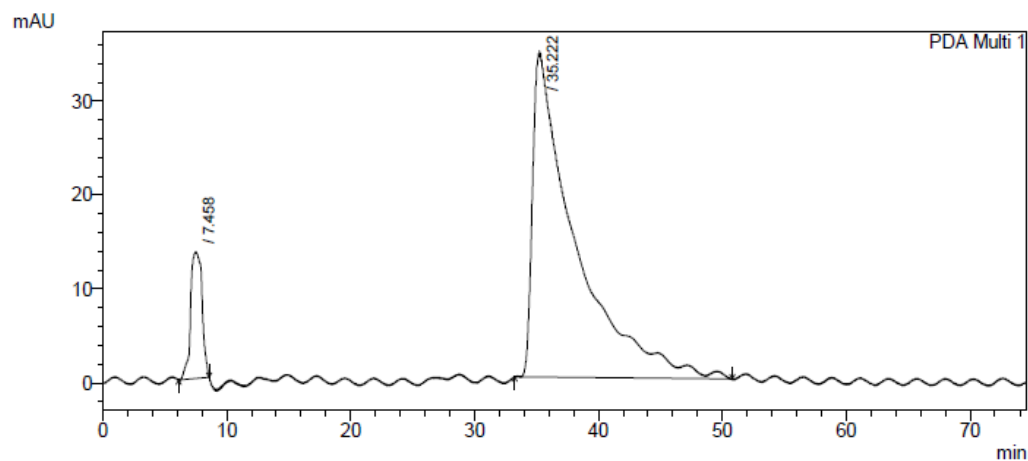


PDA Ch1 254nm 4nm

PeakTable

Name	Peak#	Ret. Time	Area	Height	Area %	Height %
	1	7.553	912668	13193	12.179	34.863
	2	36.317	6580894	24651	87.821	65.137
	Total		7493562	37844	100.000	100.000

Figure S33. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9a) and Toluene/K^tOBu condition.



PDA Ch1 254nm 4nm

PeakTable

Name	Peak#	Ret. Time	Area	Height	Area %	Height %
	1	7.458	859206	13478	9.480	27.959
	2	35.222	8204394	34730	90.520	72.041
	Total		9063600	48208	100.000	100.000

Figure S34. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9b) and Toluene/K^tOBU condition.

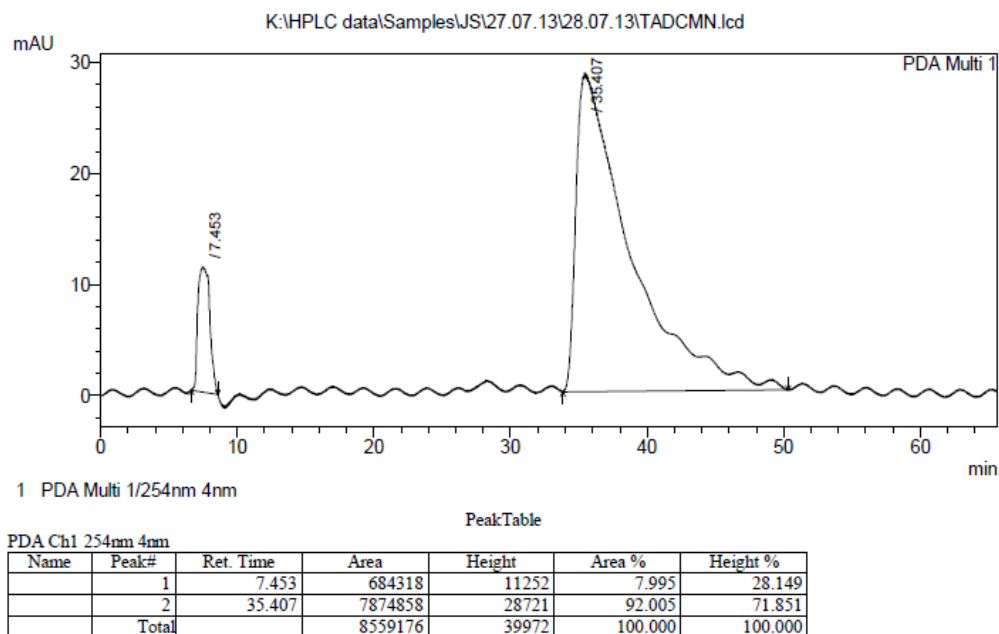


Figure S35. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9a) and Cyclohexane/K₂CO₃ condition.

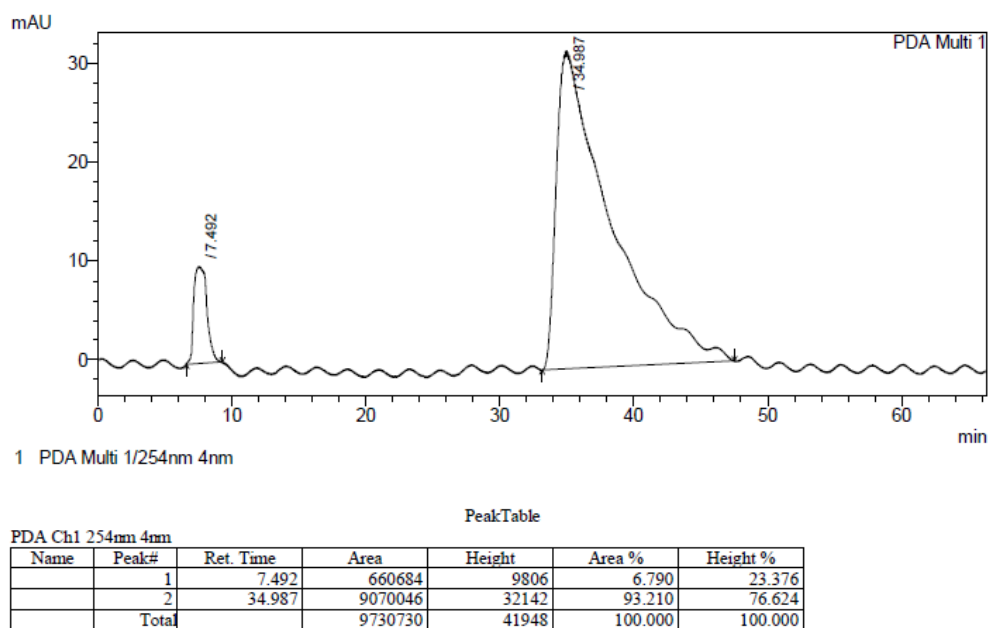


Figure S36. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9b) and Cyclohexane/K₂CO₃ condition.

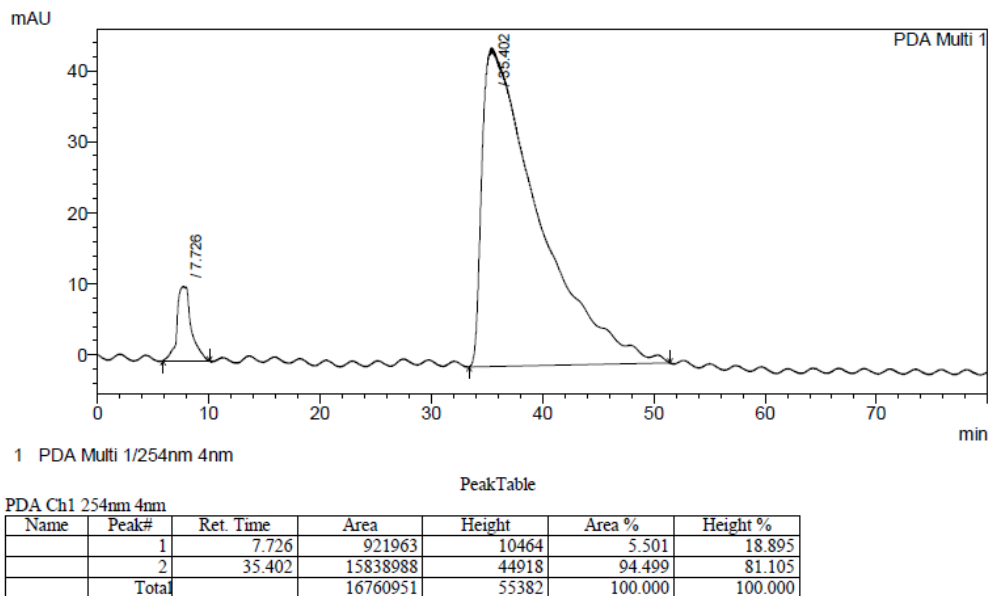


Figure S37. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9a) and THF/K₂CO₃ condition.

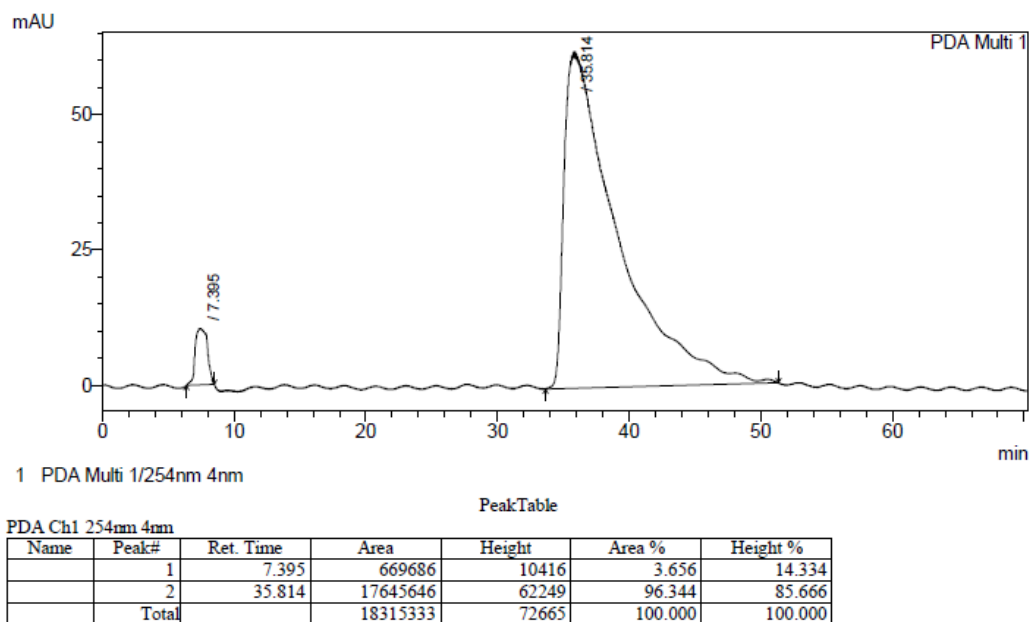
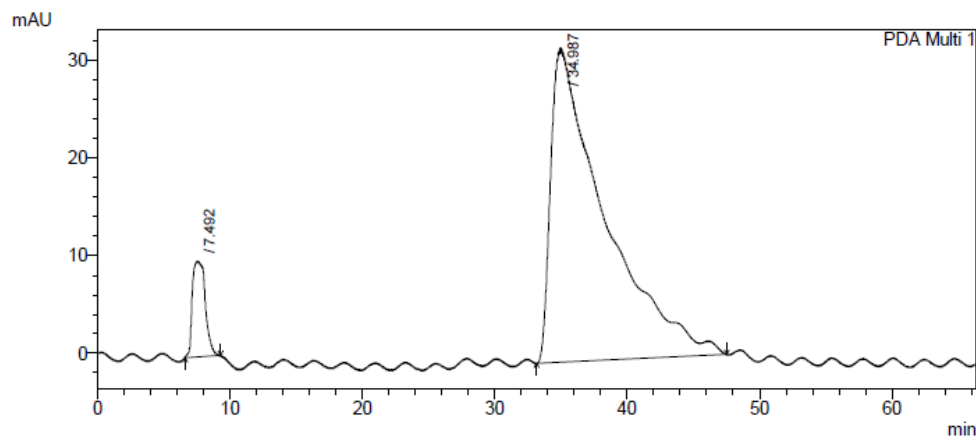


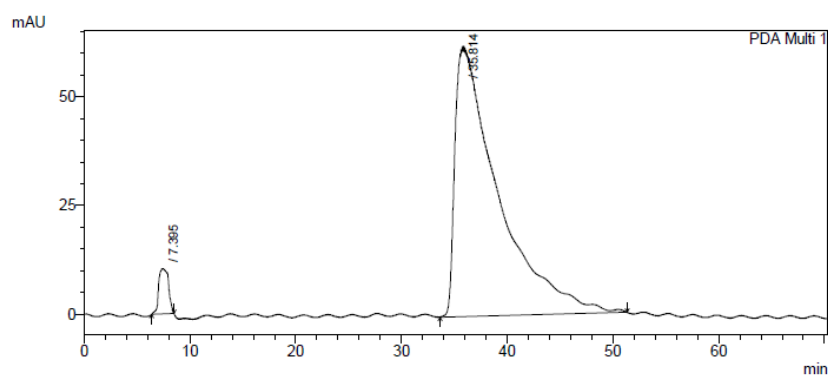
Figure S38. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9b) and THF/K₂CO₃ condition.



PeakTable

Name	Peak#	Ret. Time	Area	Height	Area %	Height %
	1	7.492	660684	9806	6.790	23.376
	2	34.987	9070046	32142	93.210	76.624
	Total		9730730	41948	100.000	100.000

Figure S39. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9a) and ACN/K₂CO₃ condition.



PeakTable

Name	Peak#	Ret. Time	Area	Height	Area %	Height %
	1	7.395	669686	10416	3.656	14.334
	2	35.814	17645646	62249	96.344	85.666
	Total		18315333	72665	100.000	100.000

Figure S40. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9b) and ACN/K₂CO₃ condition.

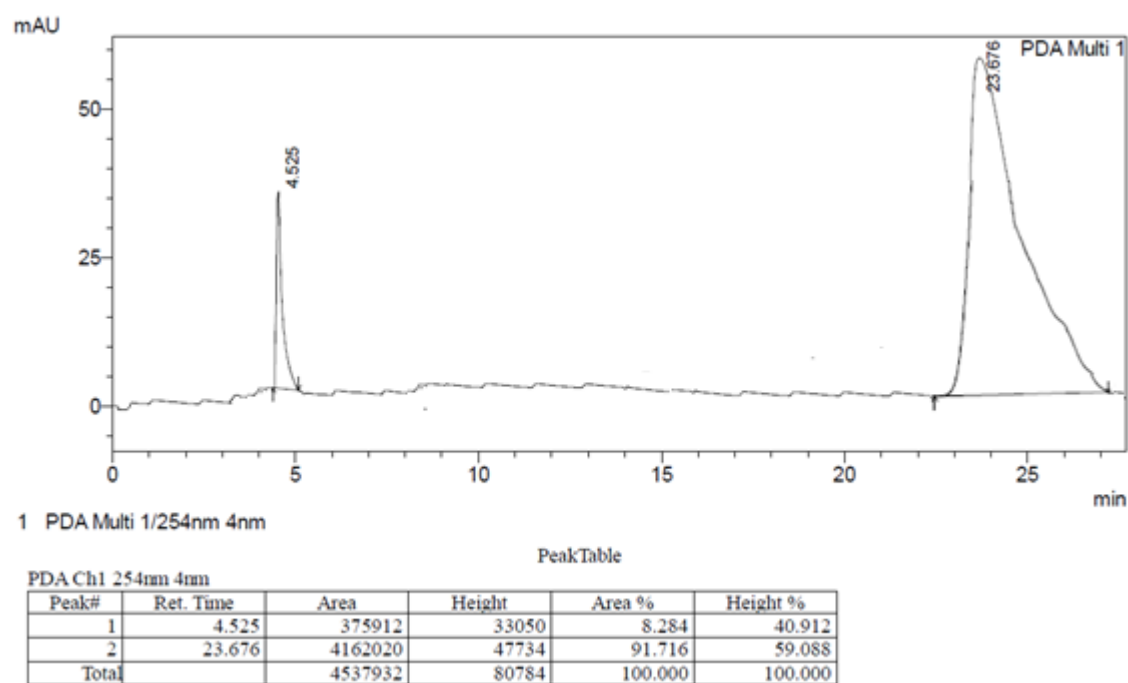


Figure S41. HPLC spectrum of Michael Adduct (5b) in presence of CMPTC (9a) and Toluene/K₂CO₃ condition.

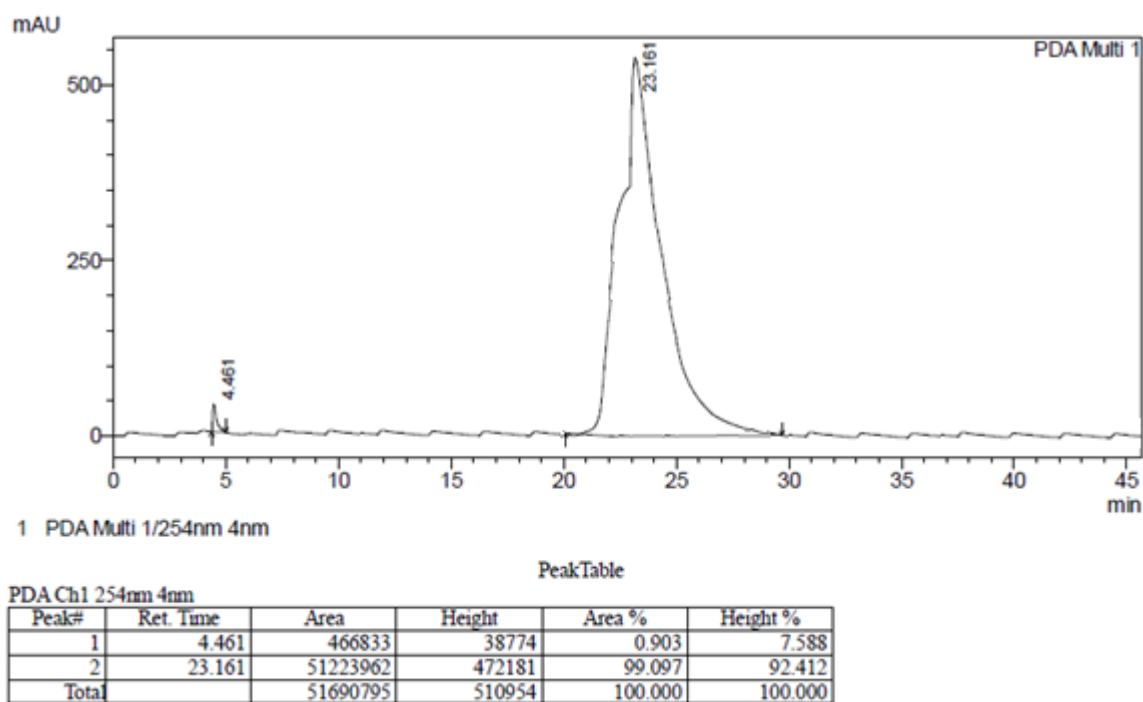
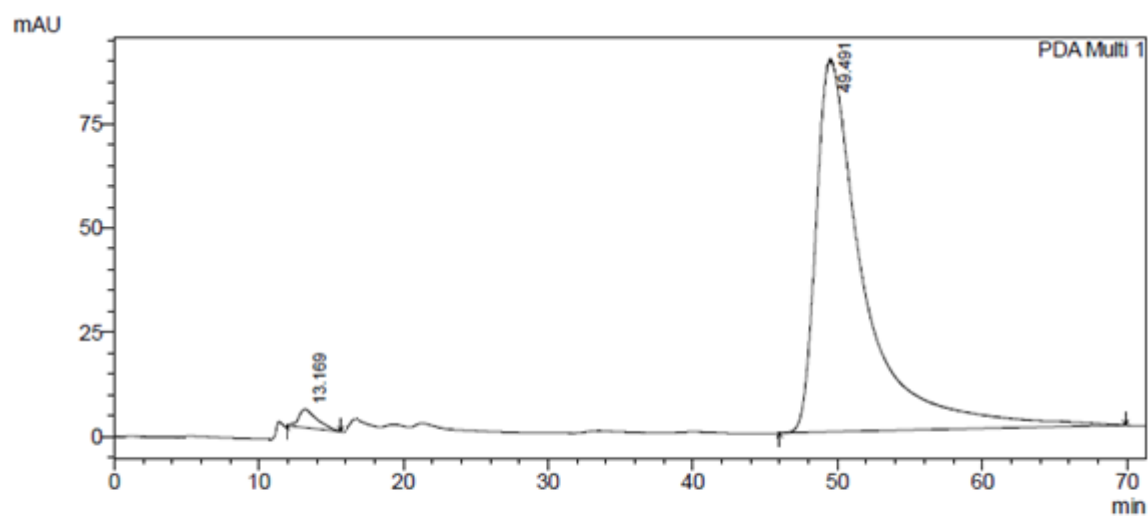


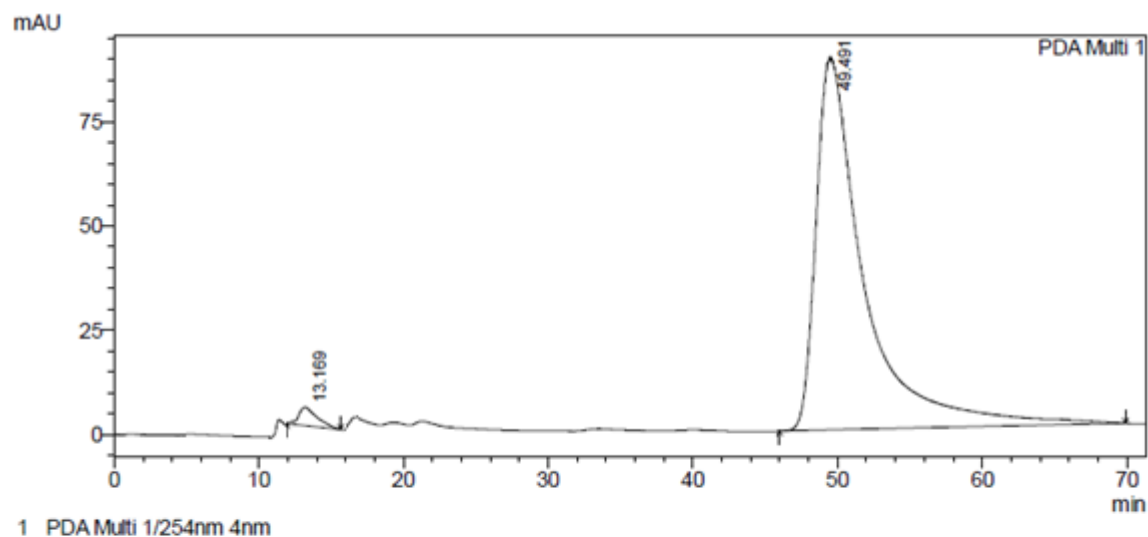
Figure S42. HPLC spectrum of Michael Adduct (5b) in presence of CMPTC (9b) and Toluene/K₂CO₃ condition.



PeakTable

Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.169	391597	4333	1.857	4.614
2	49.491	20696094	89569	98.143	95.386
Total		21087691	93902	100.000	100.000

Figure S43. HPLC spectrum of Michael Adduct (5c) in presence of CMPTC (9a) and Toluene/ K_2CO_3 condition.



PeakTable

Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.169	391597	4333	1.857	4.614
2	49.491	20696094	89569	98.143	95.386
Total		21087691	93902	100.000	100.000

Figure S44. HPLC spectrum of Michael Adduct (5c) in presence of CMPTC (9b) and Toluene/ K_2CO_3 condition.

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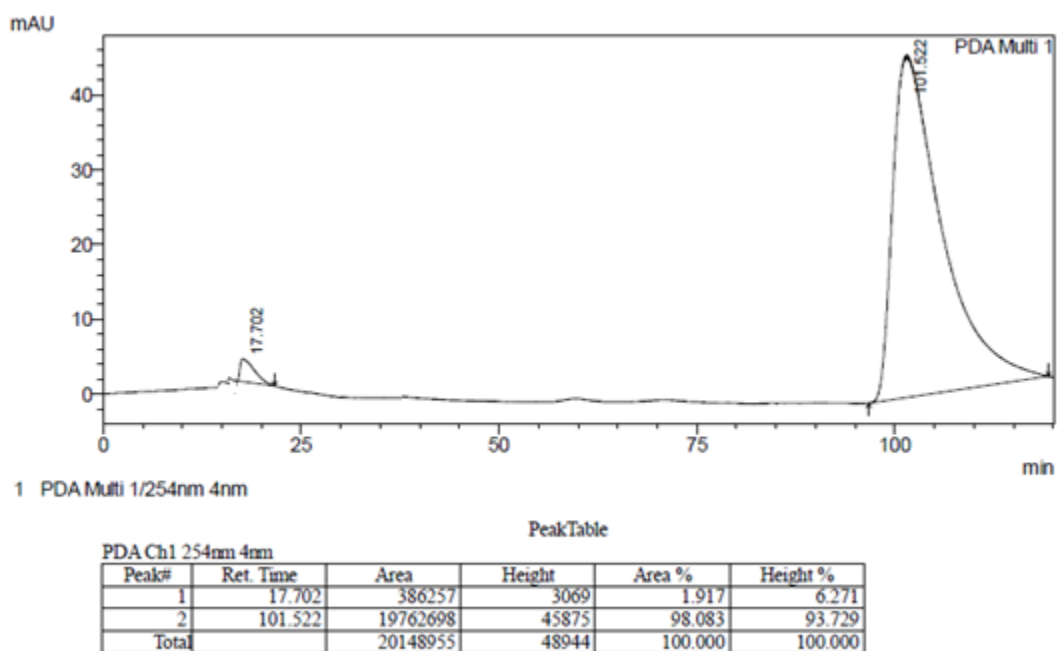


Figure S45. HPLC spectrum of Michael Adduct (5d) in presence of CMPTC (9a) and Toluene/K₂CO₃ condition.

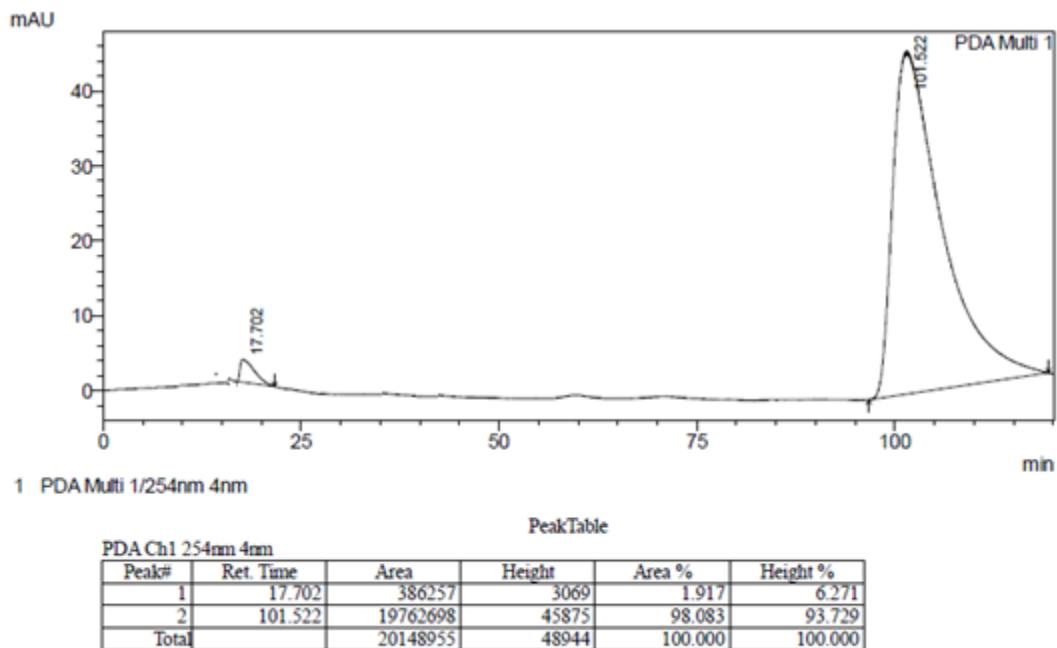
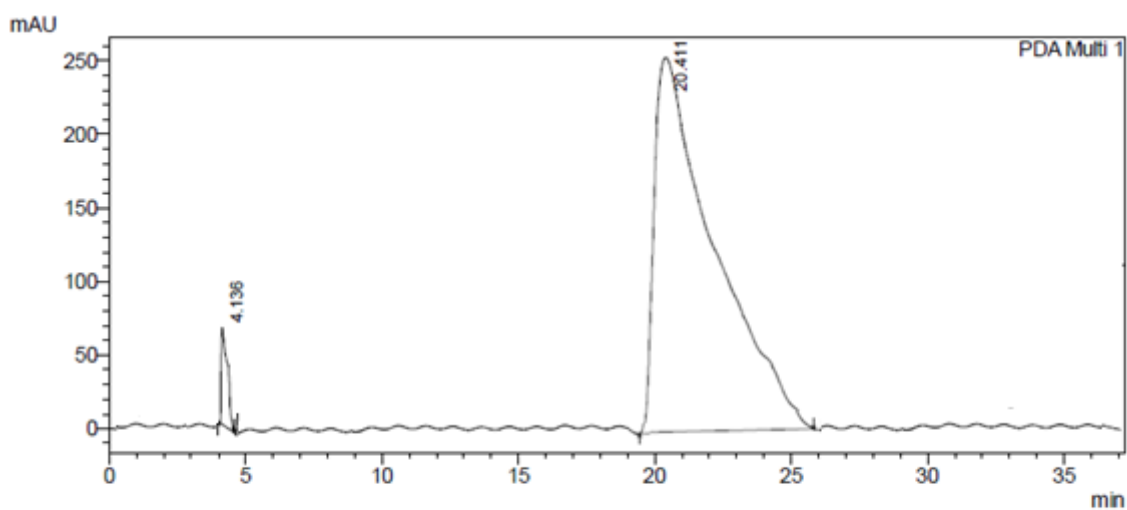


Figure S46. HPLC spectrum of Michael Adduct (5d) in presence of CMPTC (9b) and Toluene/K₂CO₃ condition.

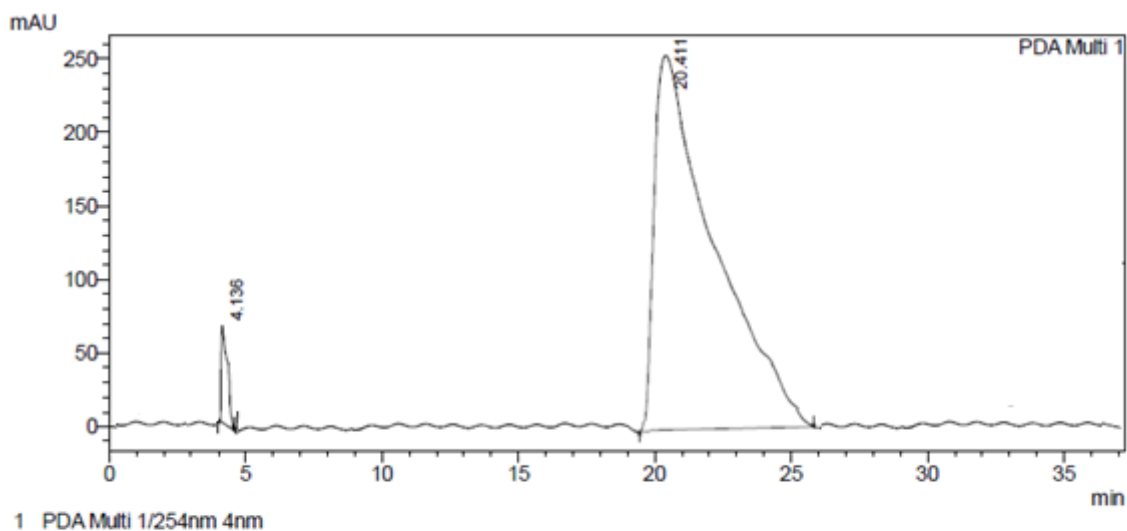
Supporting Information



PeakTable

Peak#	Ret. Time	Area	Height	Area %	Height %
1	4.136	1051451	65677	5.956	25.412
2	20.411	16603042	192775	94.044	74.588
Total		17654493	258452	100.000	100.000

Figure S47. HPLC spectrum of Michael Adduct (5e) in presence of CMPTC (9a) and Toluene/K₂CO₃ condition.

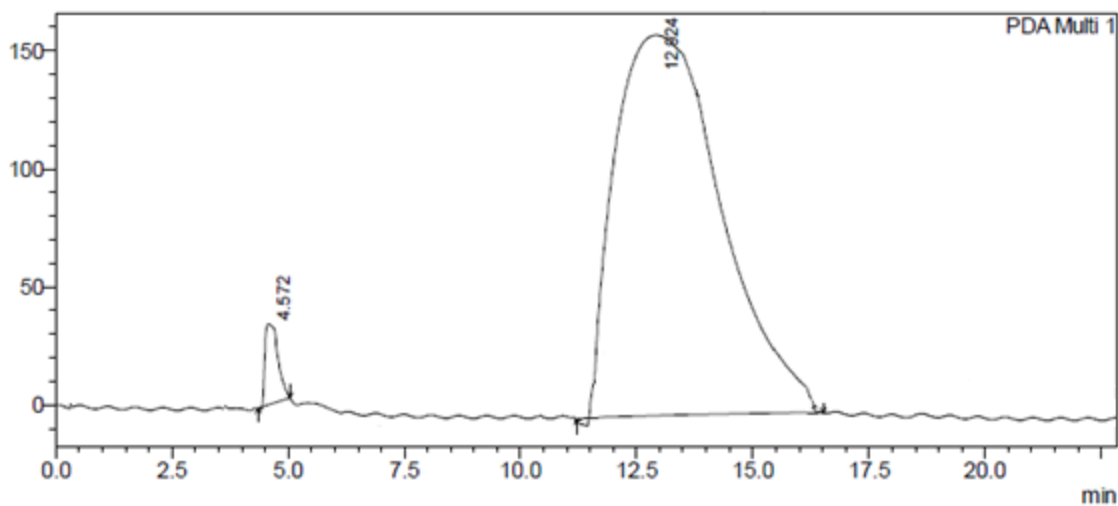


PeakTable

Peak#	Ret. Time	Area	Height	Area %	Height %
1	4.136	1051451	65677	5.956	25.412
2	20.411	16603042	192775	94.044	74.588
Total		17654493	258452	100.000	100.000

Figure S48. HPLC spectrum of Michael Adduct (5e) in presence of CMPTC (9b) and Toluene/K₂CO₃ condition.

Supporting Information



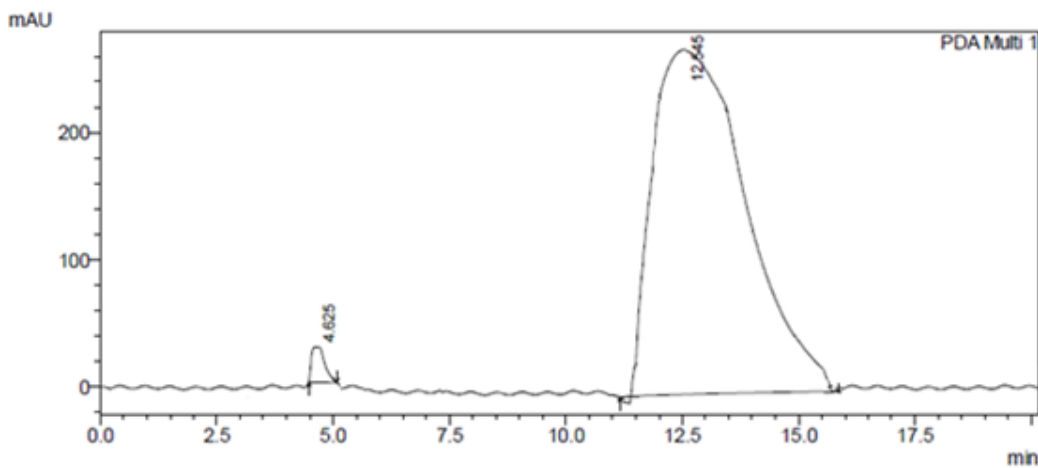
1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	4.572	654306	34050	8.476	34.542
2	12.924	7065168	64526	91.524	65.458
Total		7719474	98575	100.000	100.000

Figure S49. HPLC spectrum of Michael Adduct (5f) in presence of CMPTC (9a) and Toluene/K₂CO₃ condition.



1 PDA Multi 1/254nm 4nm

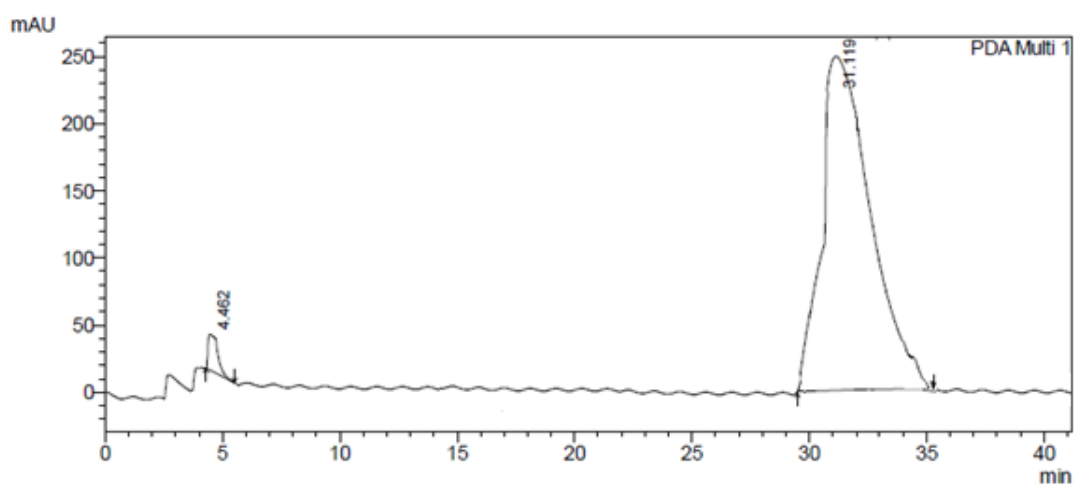
PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	4.625	549780	27787	2.727	13.368
2	12.545	19608700	180075	97.273	86.632
Total		20158479	207862	100.000	100.000

Figure S50. HPLC spectrum of Michael Adduct (5f) in presence of CMPTC (9b) and Toluene/K₂CO₃ condition.

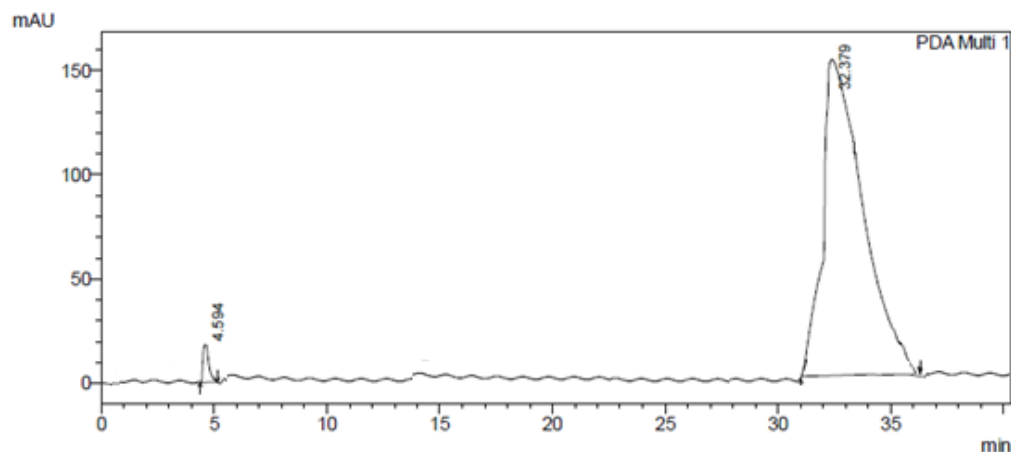
Supporting Information



PeakTable

Peak#	Ret. Time	Area	Height	Area %	Height %
1	4.462	793053	26530	5.094	13.931
2	31.119	14774141	163910	94.906	86.069
Total		15567194	190441	100.000	100.000

Figure S51. HPLC spectrum of Michael Adduct (5g) in presence of CMPTC (9a) and Toluene/K₂CO₃ condition.



PeakTable

Peak#	Ret. Time	Area	Height	Area %	Height %
1	4.594	330906	18072	2.746	14.555
2	32.379	11717830	106092	97.254	85.445
Total		12048736	124164	100.000	100.000

Figure S52. HPLC spectrum of Michael Adduct (5g) in presence of CMPTC (9b) and Toluene/K₂CO₃ condition.

Supporting Information

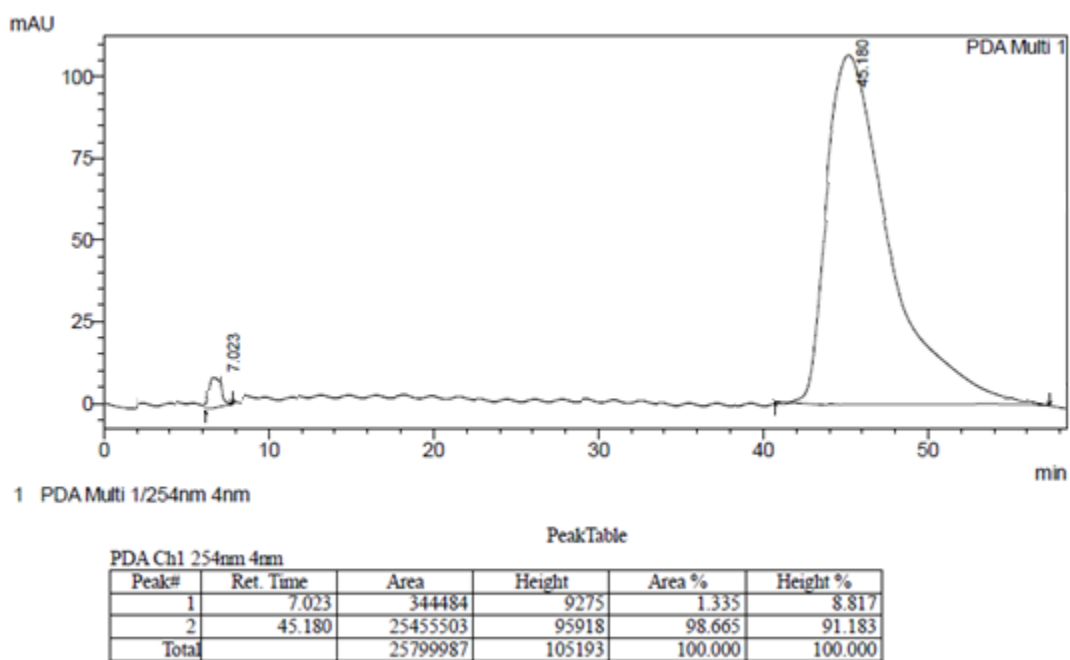


Figure S53. HPLC spectrum of Michael Adduct (5h) in presence of CMPTC (9a) and Toluene/K₂CO₃ condition.

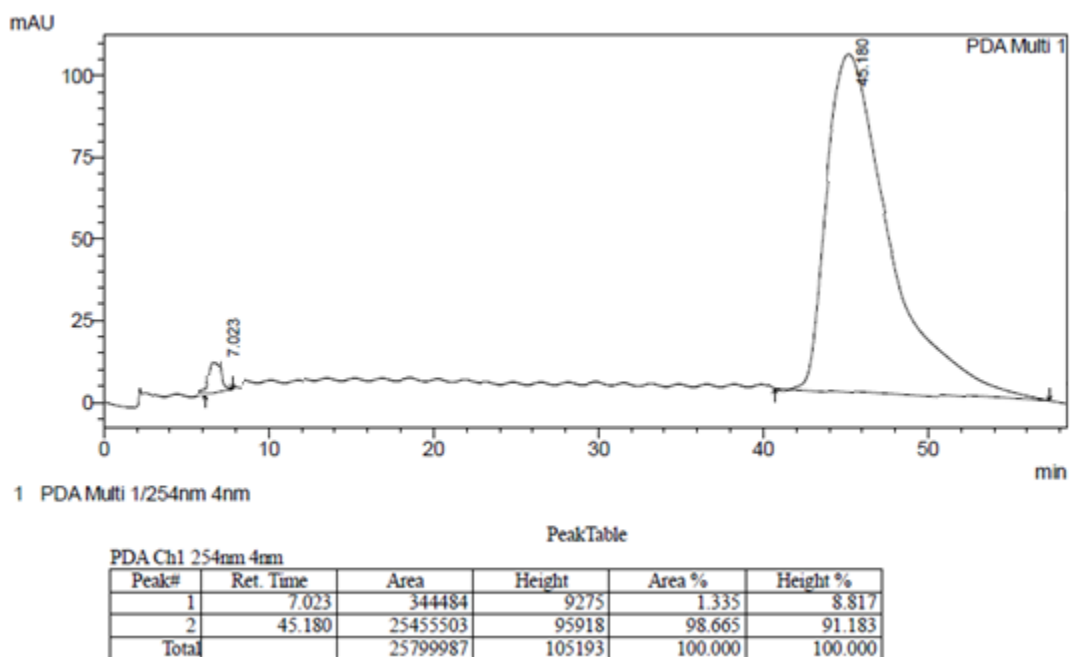
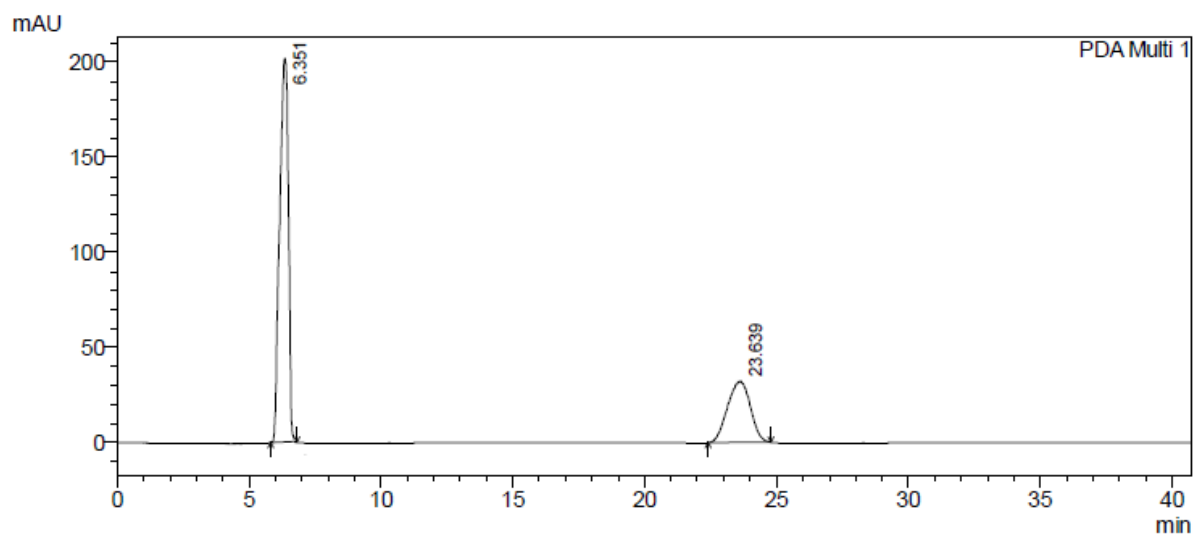


Figure S54. HPLC spectrum of Michael Adduct (5h) in presence of CMPTC (9b) and Toluene/K₂CO₃ condition.



1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.351	4665702	201365	70.603	86.181
2	23.639	1942699	32287	29.397	13.819
Total		6608401	233652	100.000	100.000

Figure S55. HPLC spectrum of Michael Adduct (5a) in presence of CMPTC (9b) and Toluene/K₂CO₃ at room temperature.