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Synthesis and application of dual chiral [2.2]paracyclophane-based N-heterocyclic carbene in enantioselective β-boration of acyclic enones

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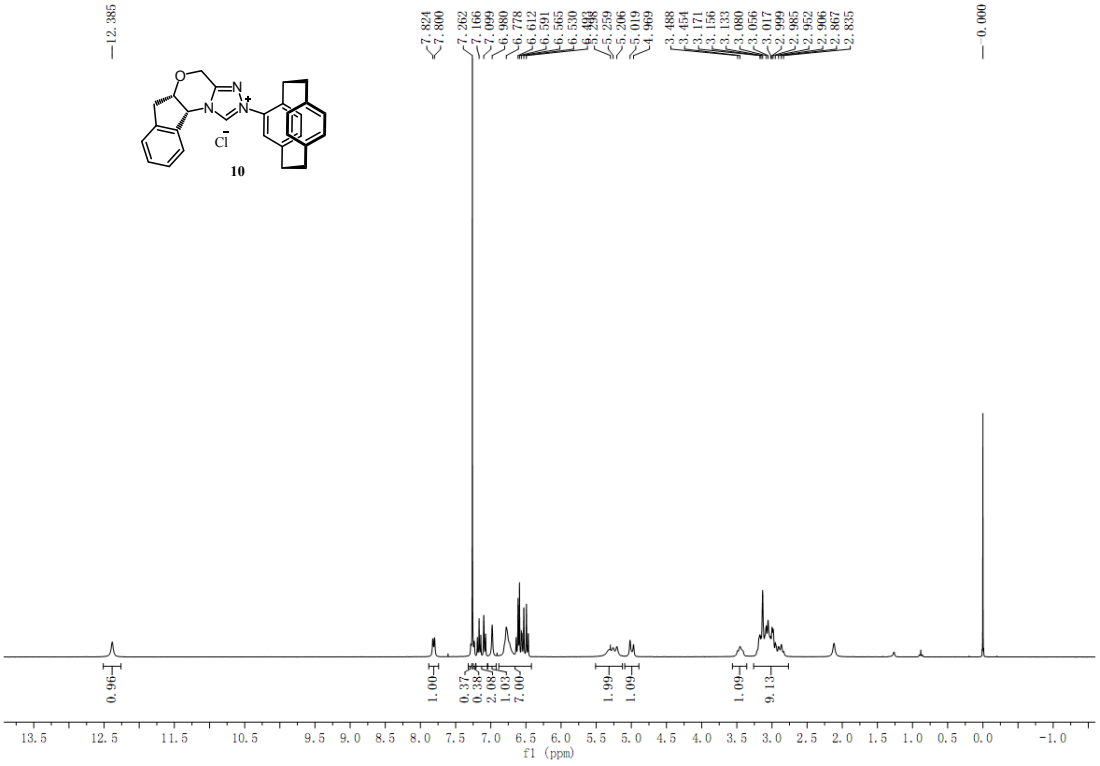
1.General information

All manipulations of oxygen- and moisture-sensitive materials were conducted with a standard Schlenk technique under a purified argon atmosphere. Solvents were reagent grade and purified by standard techniques. ^{1}H NMR and ^{13}C NMR spectra were recorded on a 300 MHz spectrometer. Chemical shifts were reported as δ values in ppm and referenced to using tetramethylsilane as an internal.All reactions were monitored by TLC with silica gel-coated plates and visualized with a UV light at 254 nm. Optical rotations were reported as follows: $[\alpha]_D^T$ (*c* = g/100 mL, solvent).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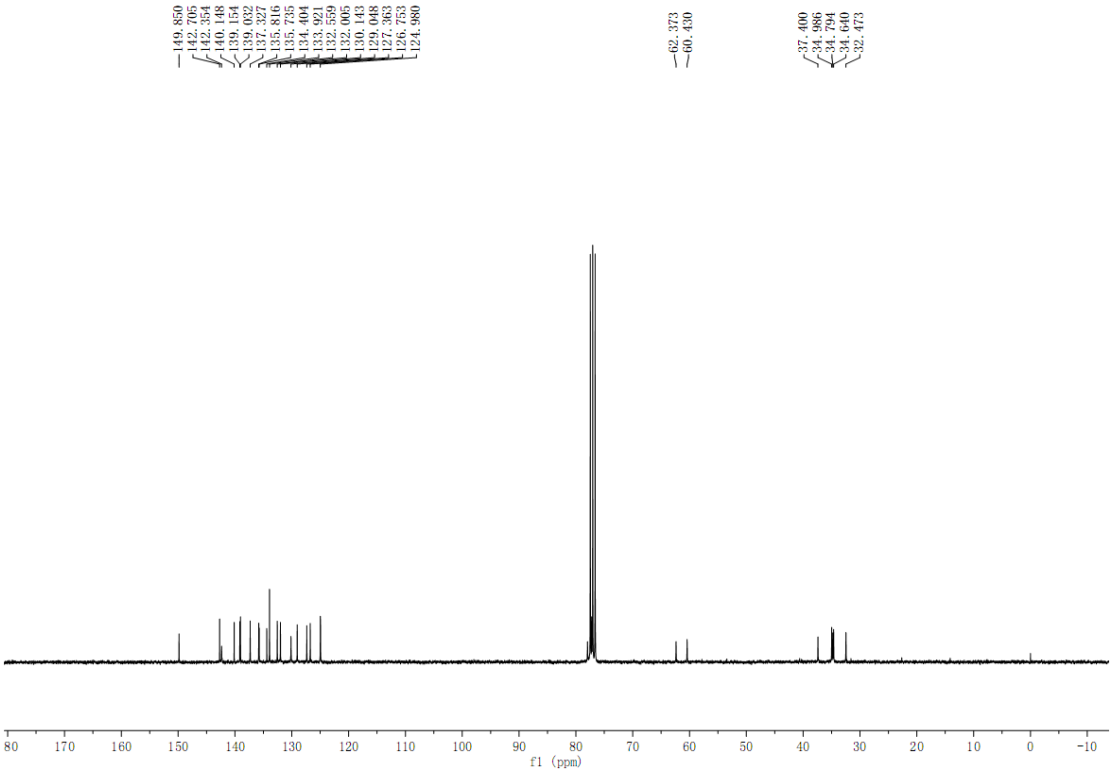
f1 (ppm)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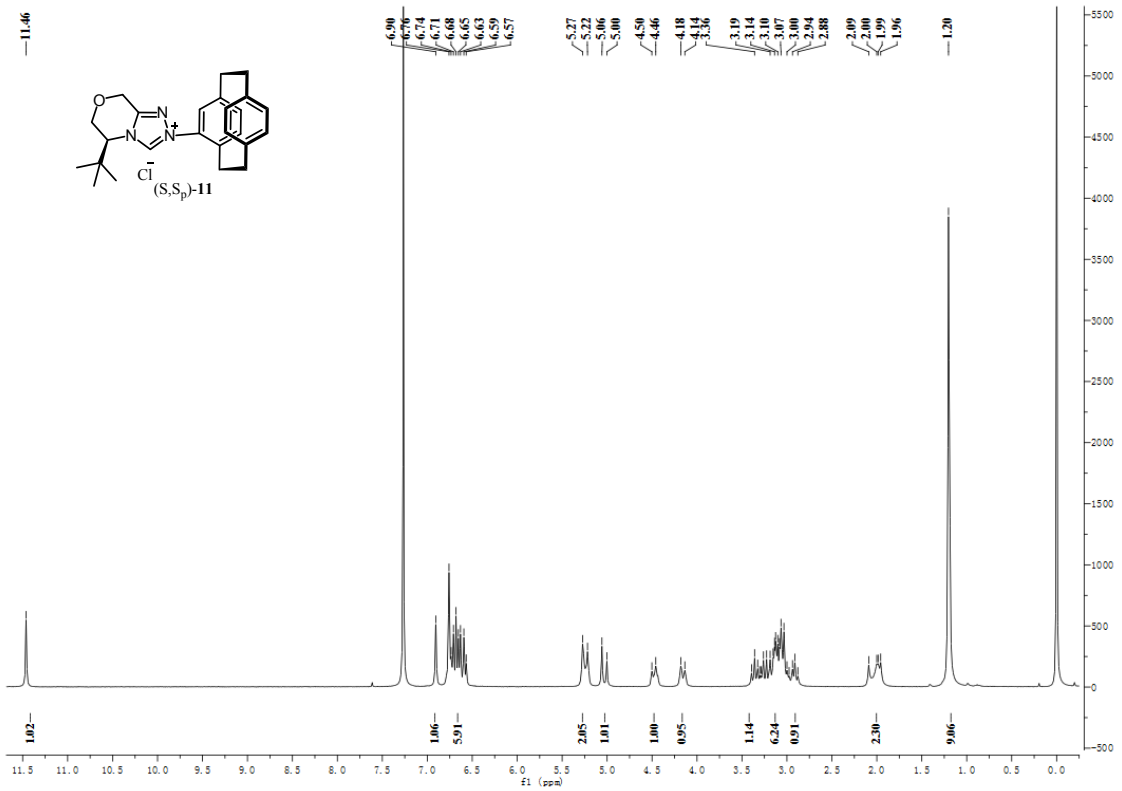
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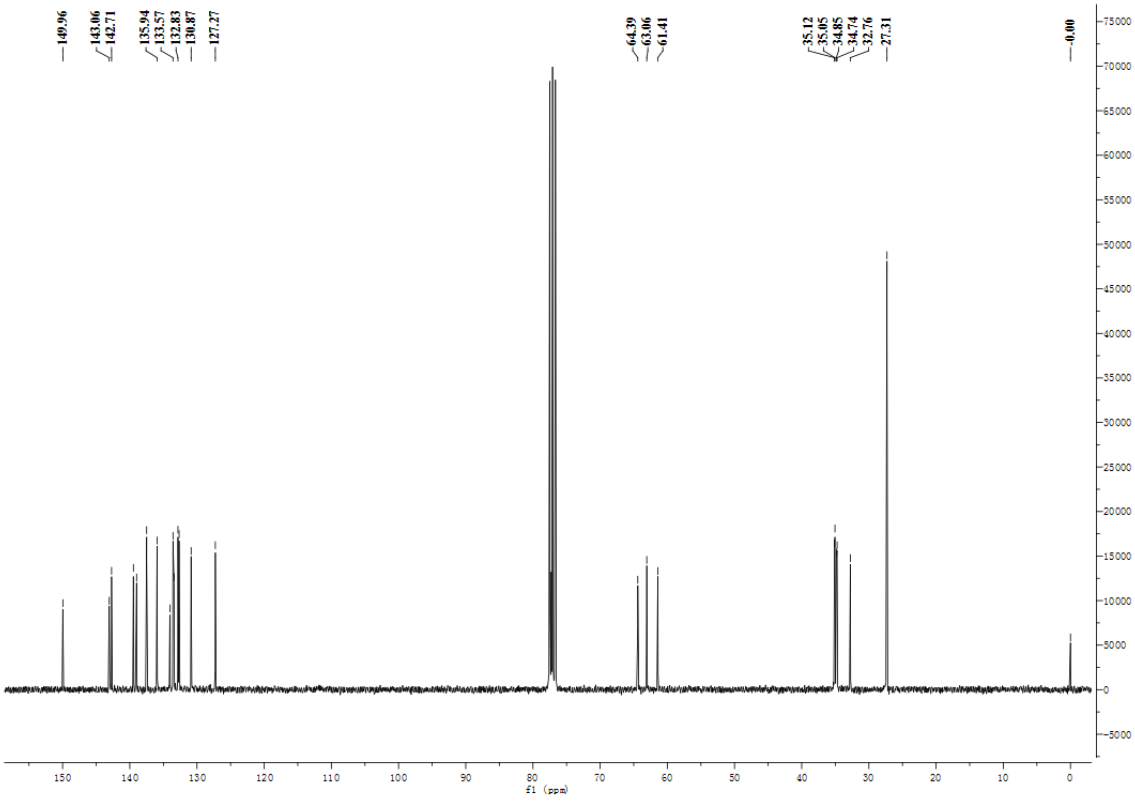
f1 (ppm)

(S,S$_p$)-**11**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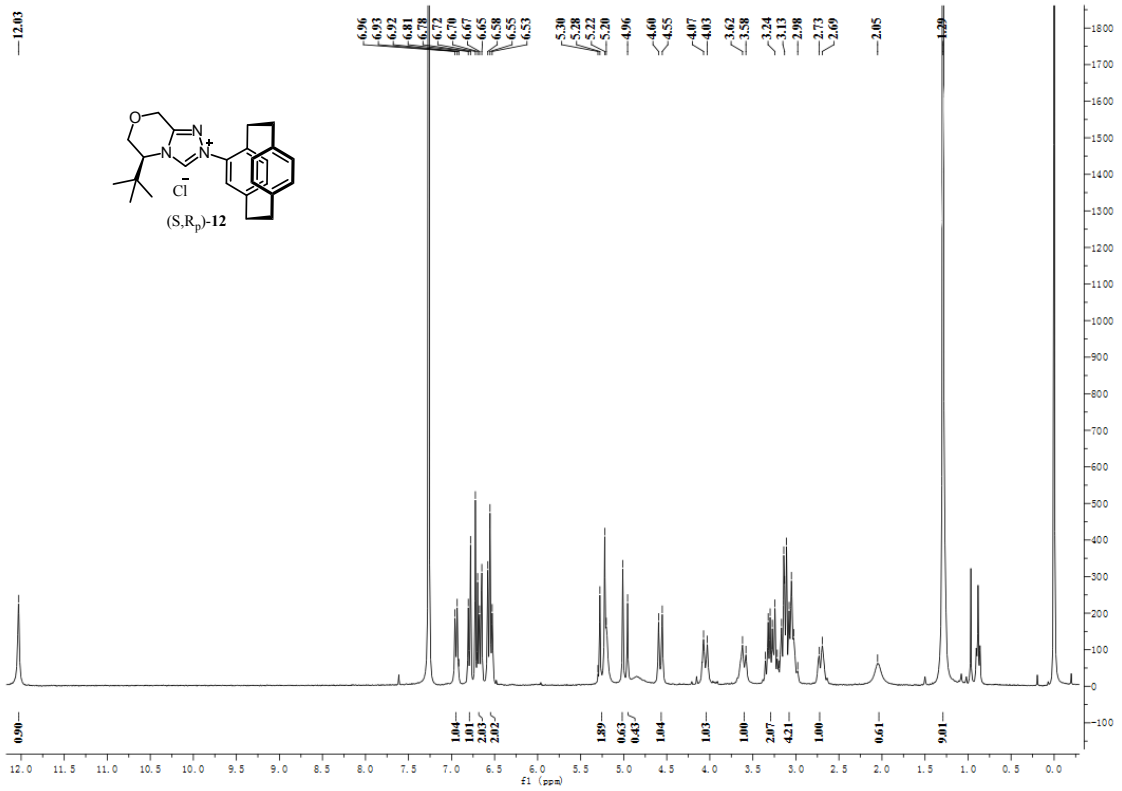
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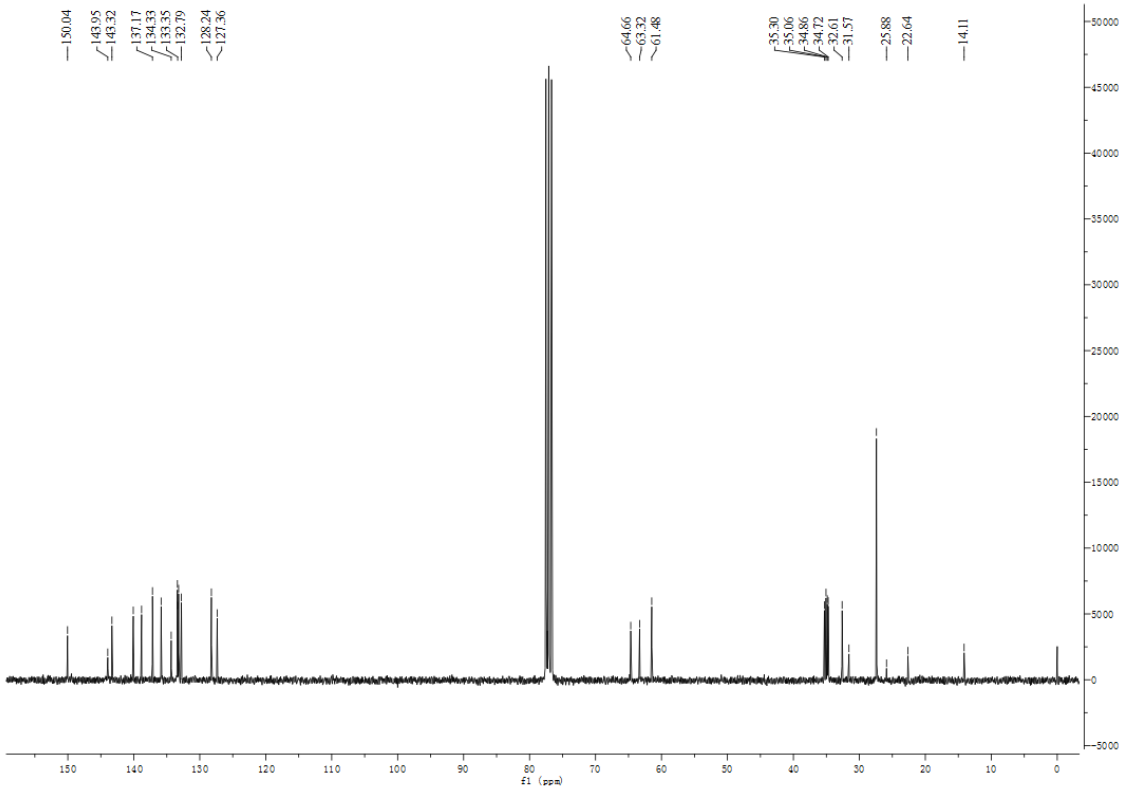
(S,R_p)-**12**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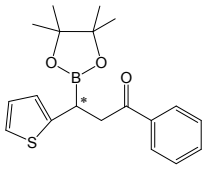
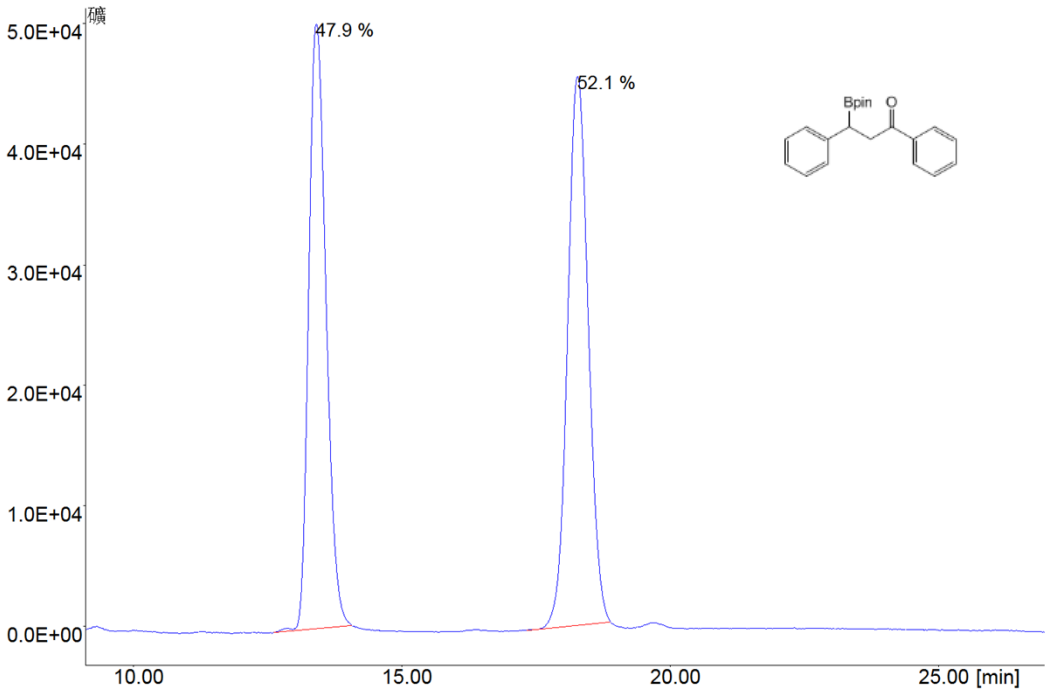
f1 (ppm)


O
B
O
O
*
S



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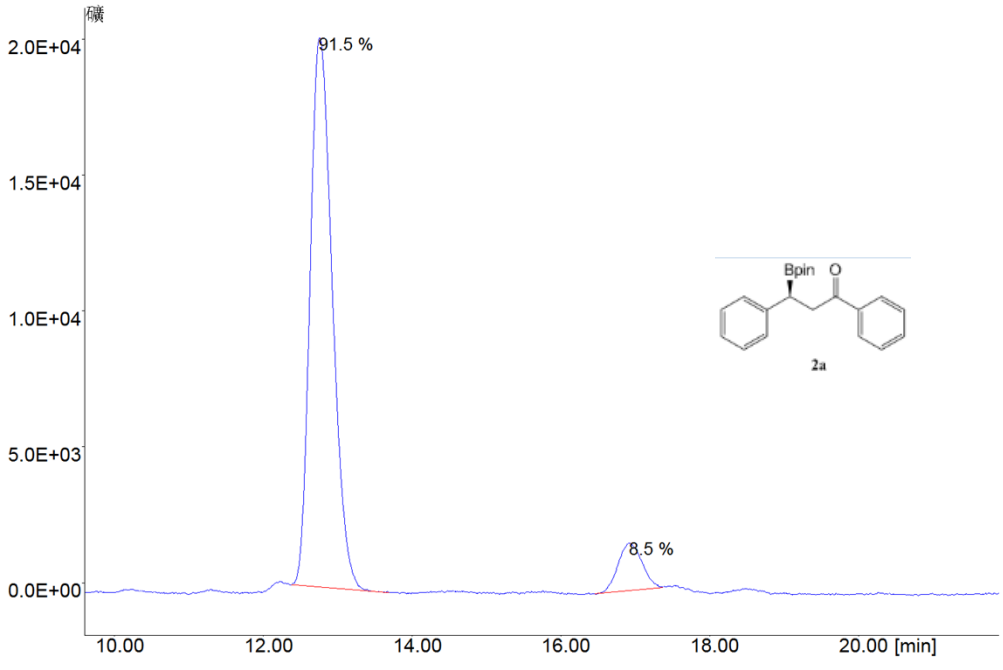

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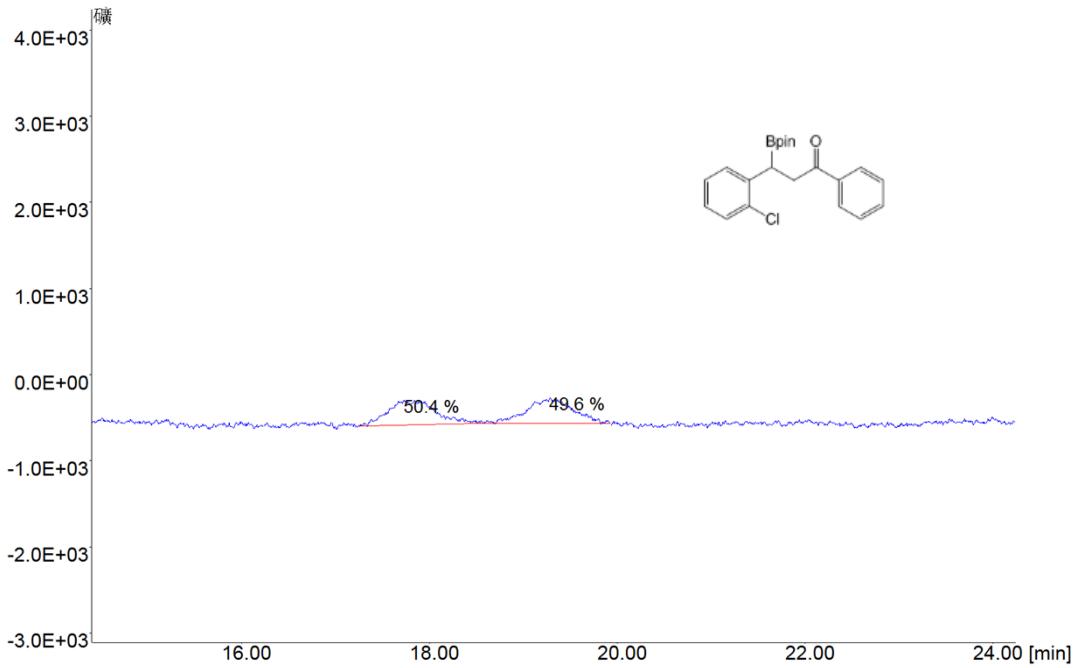

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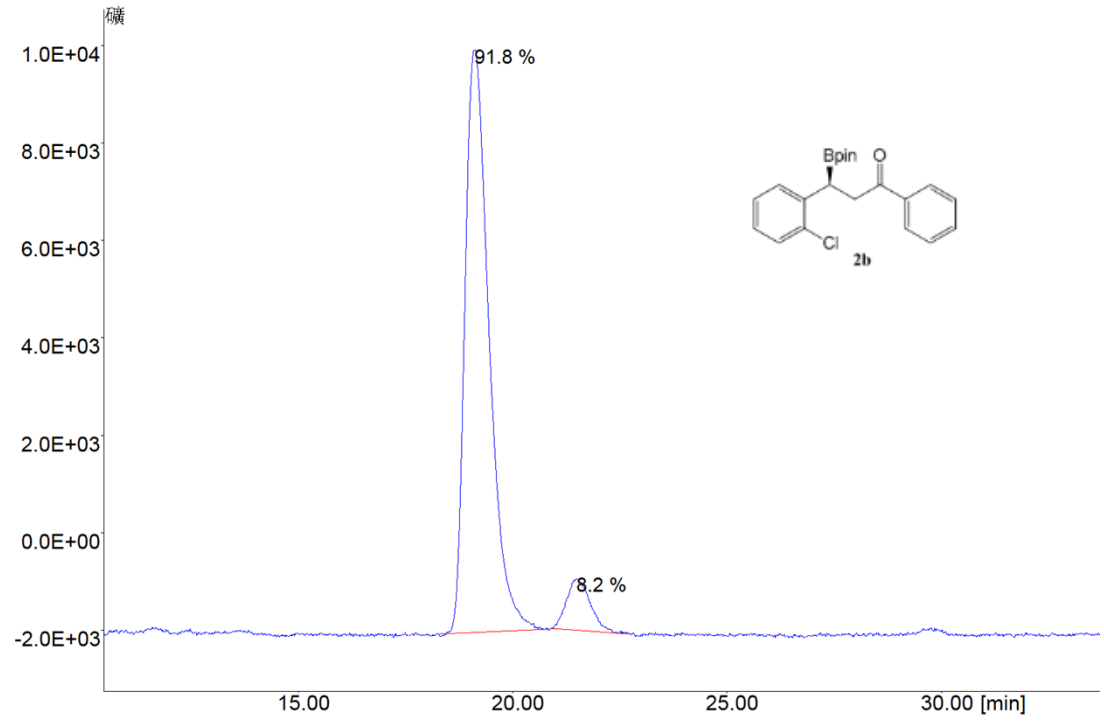

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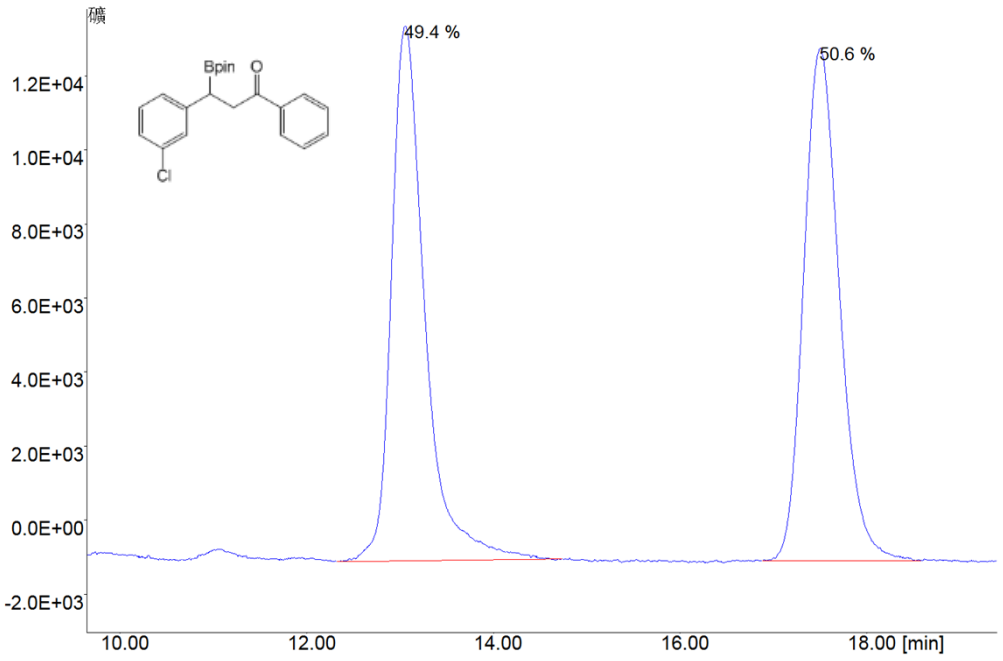

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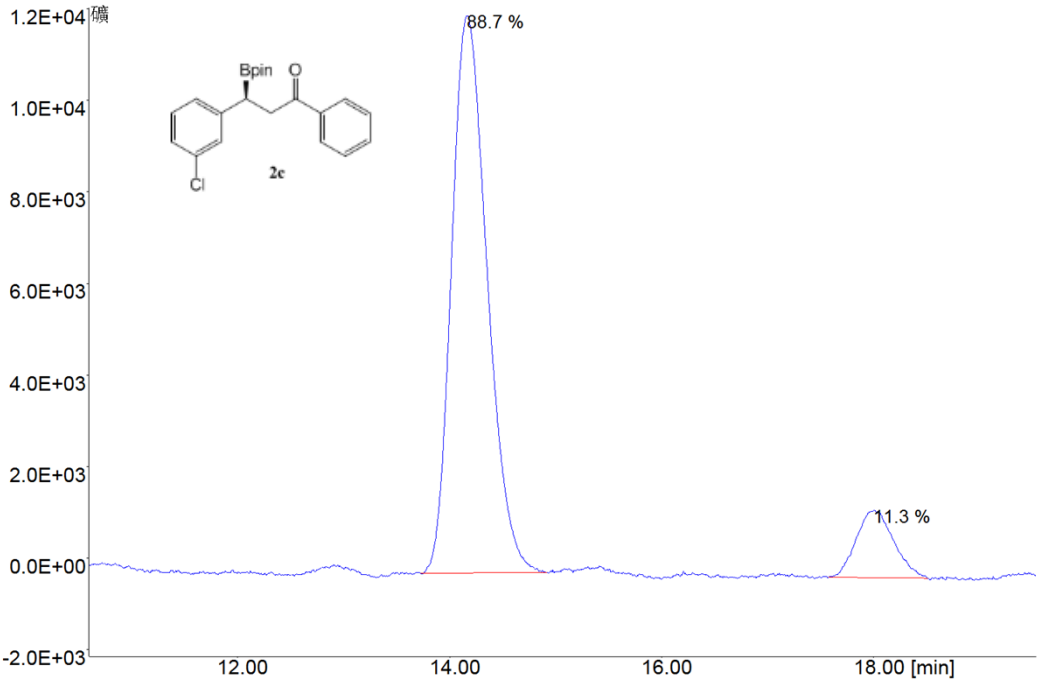

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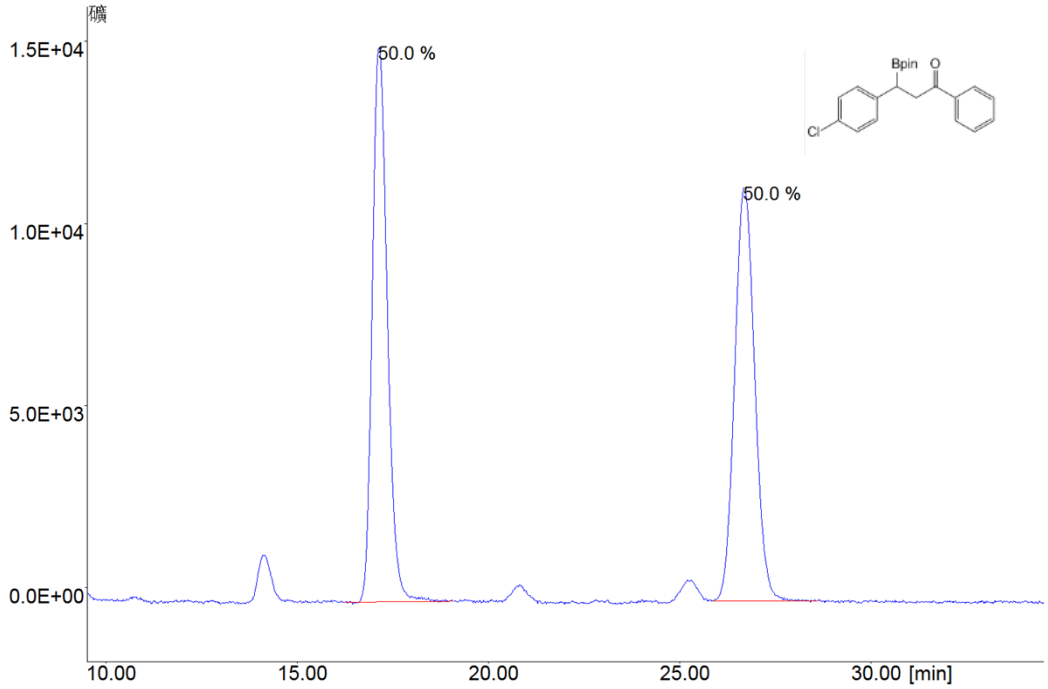

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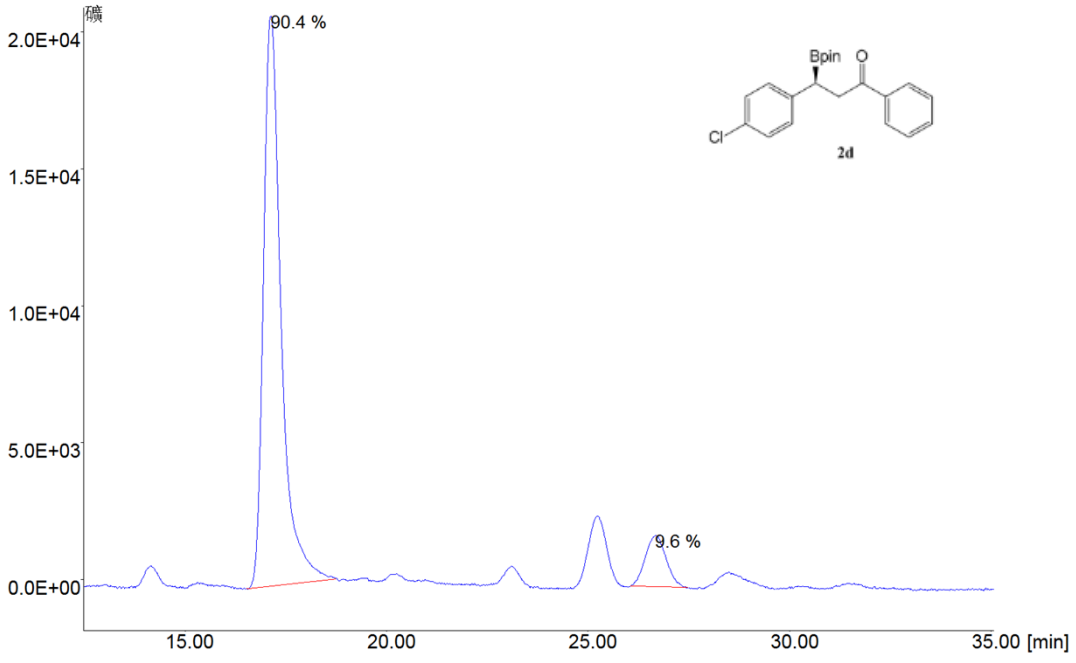

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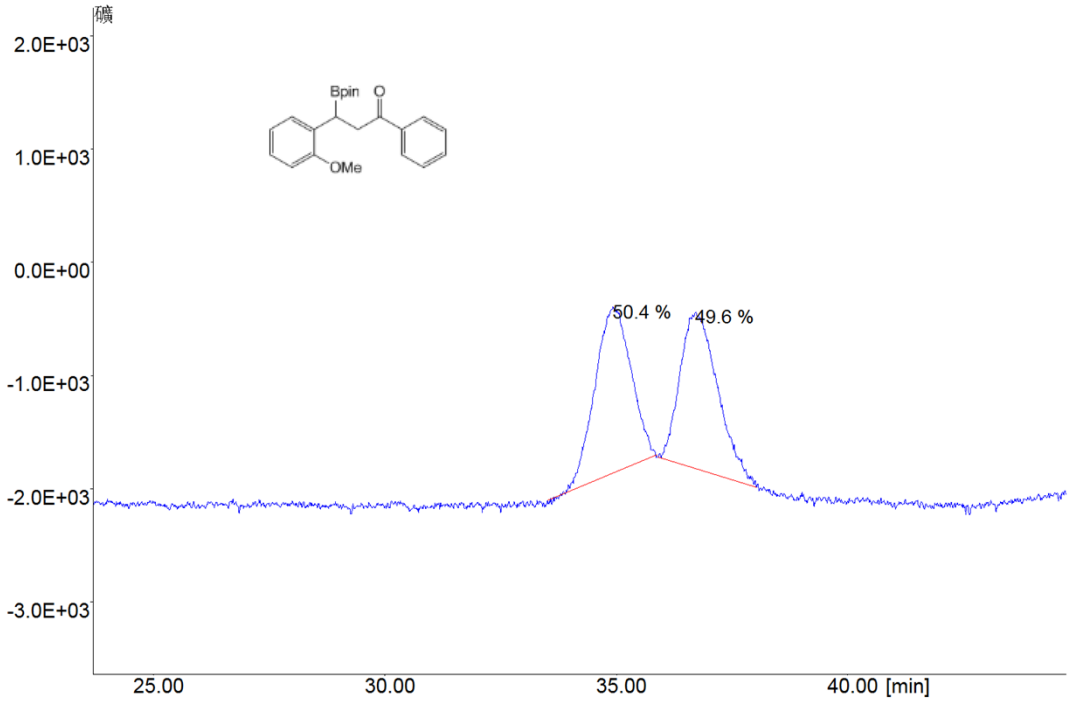

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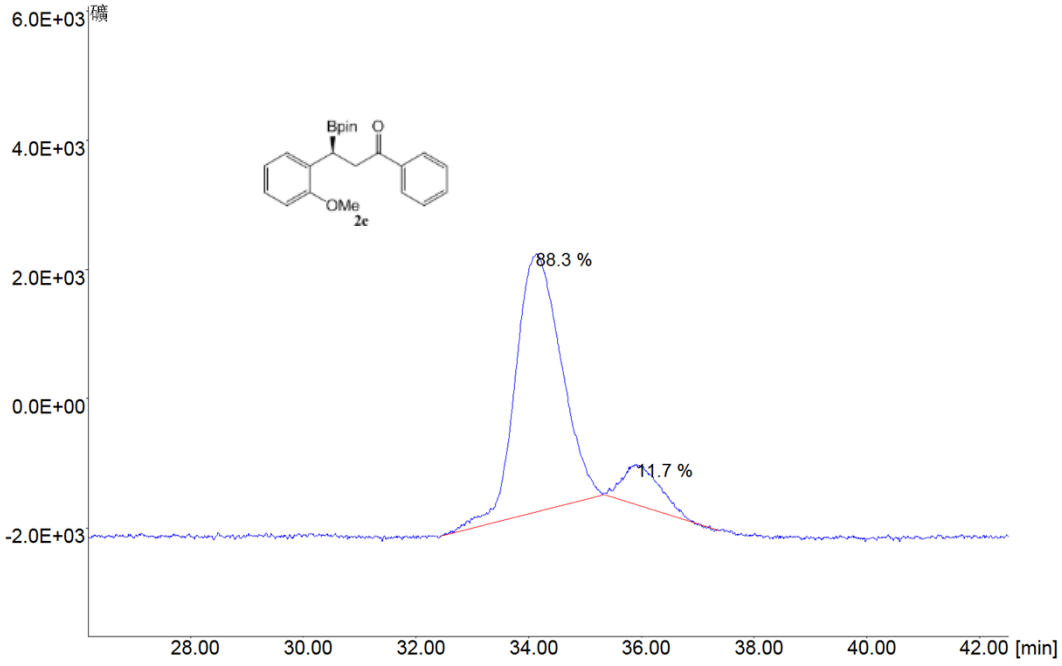

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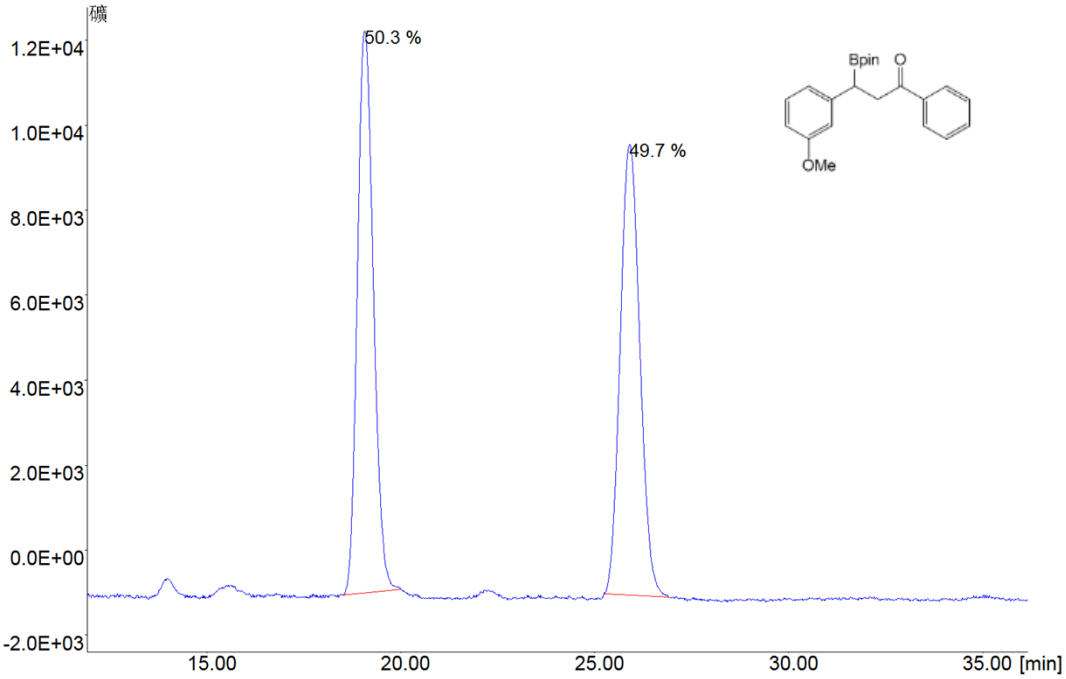

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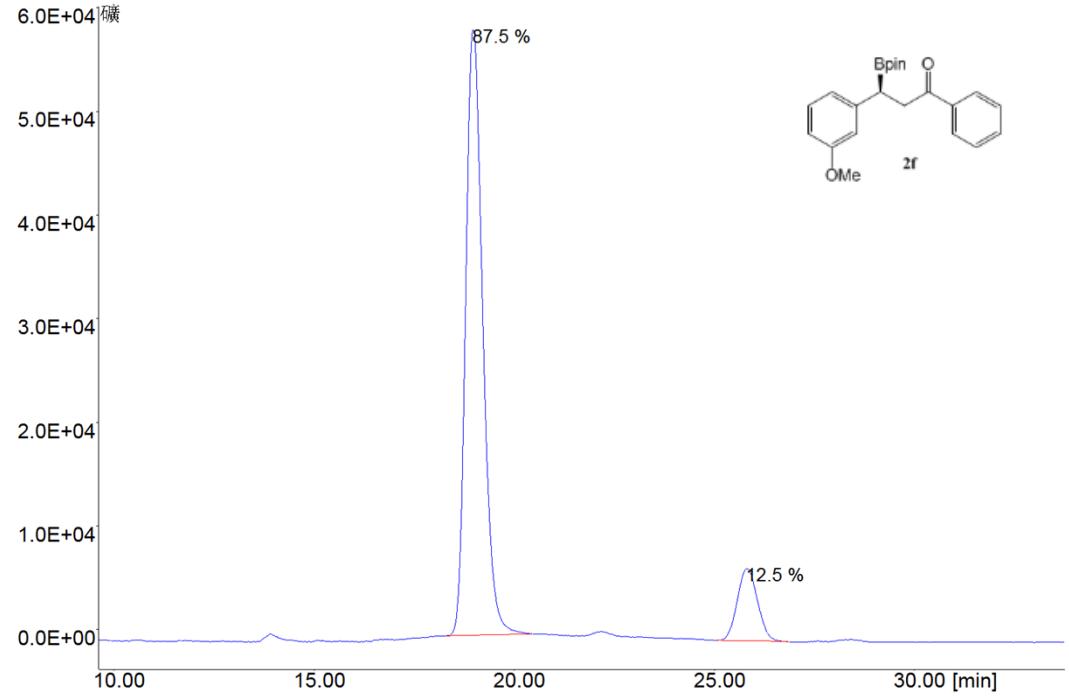

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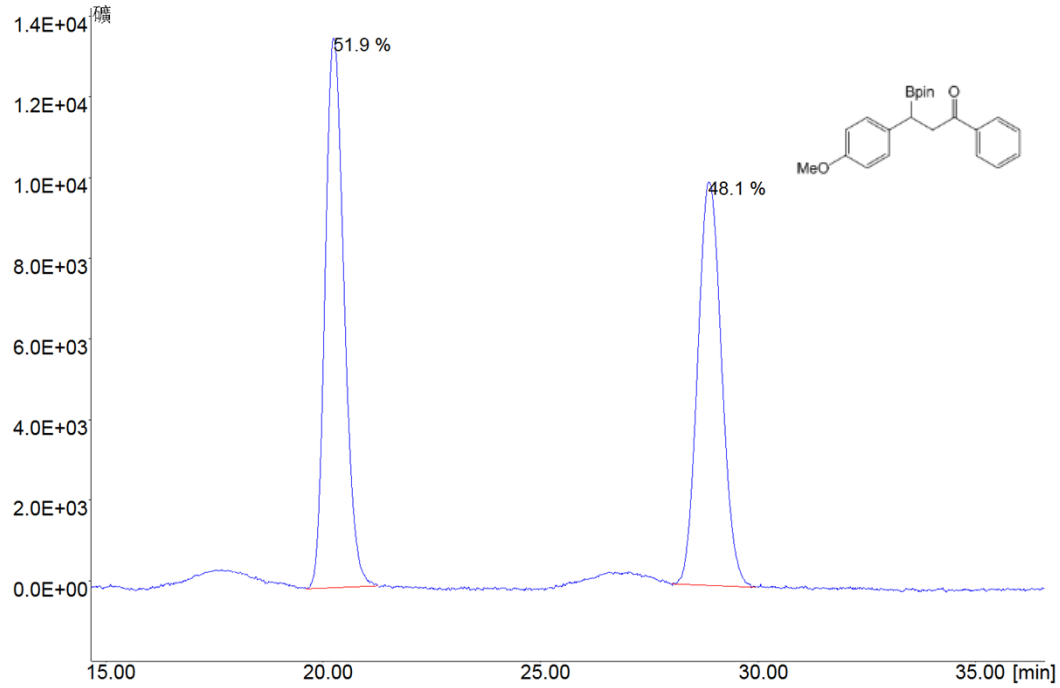

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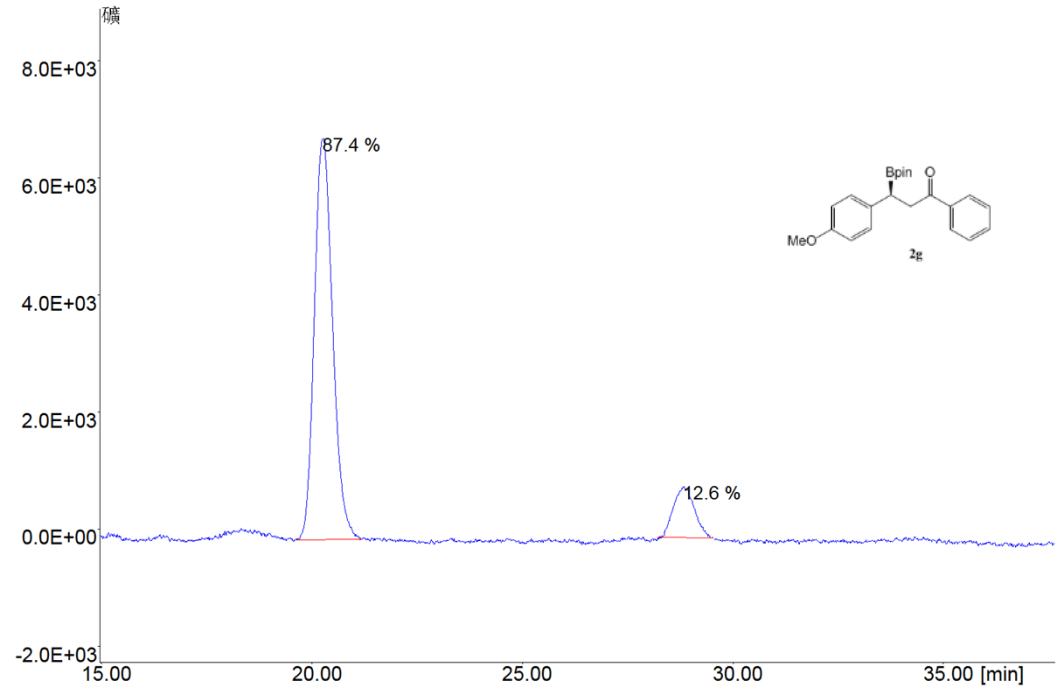

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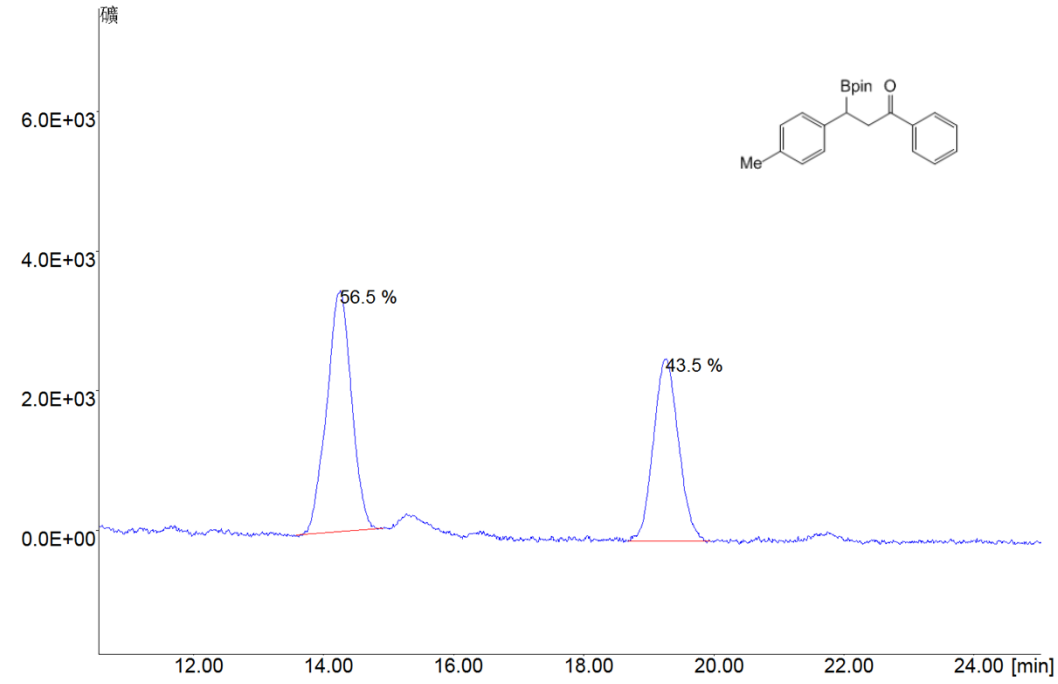

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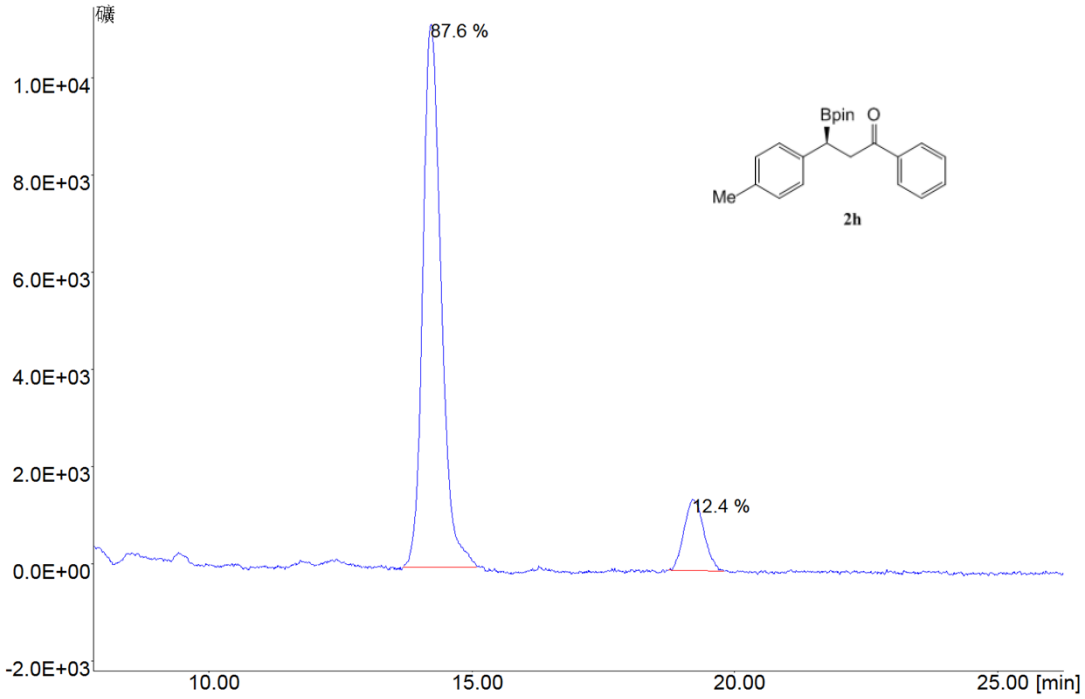

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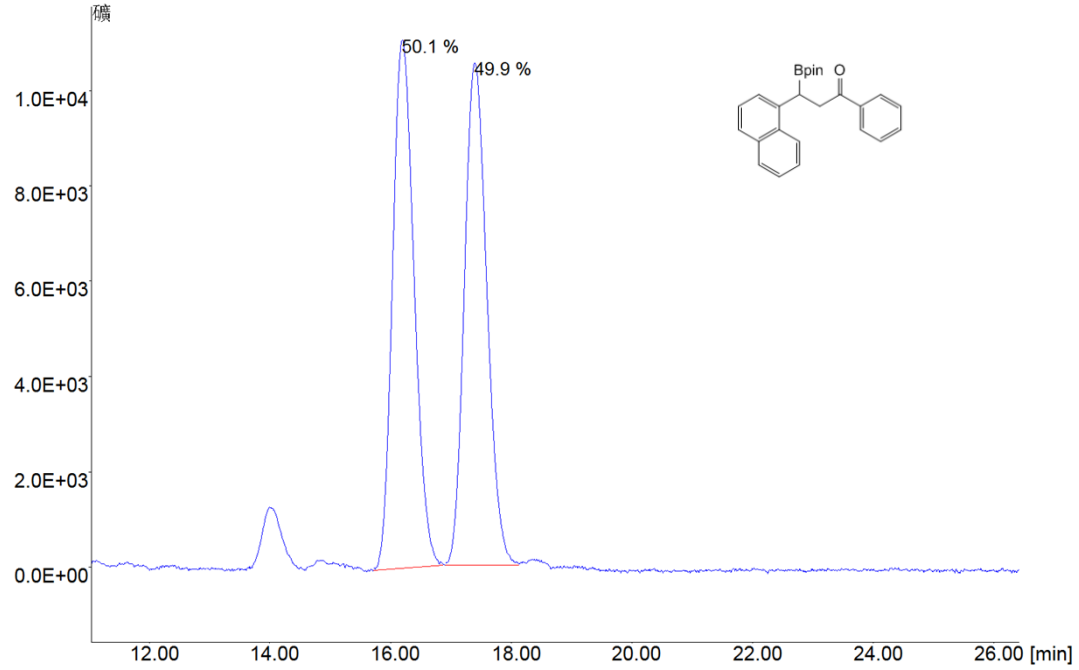

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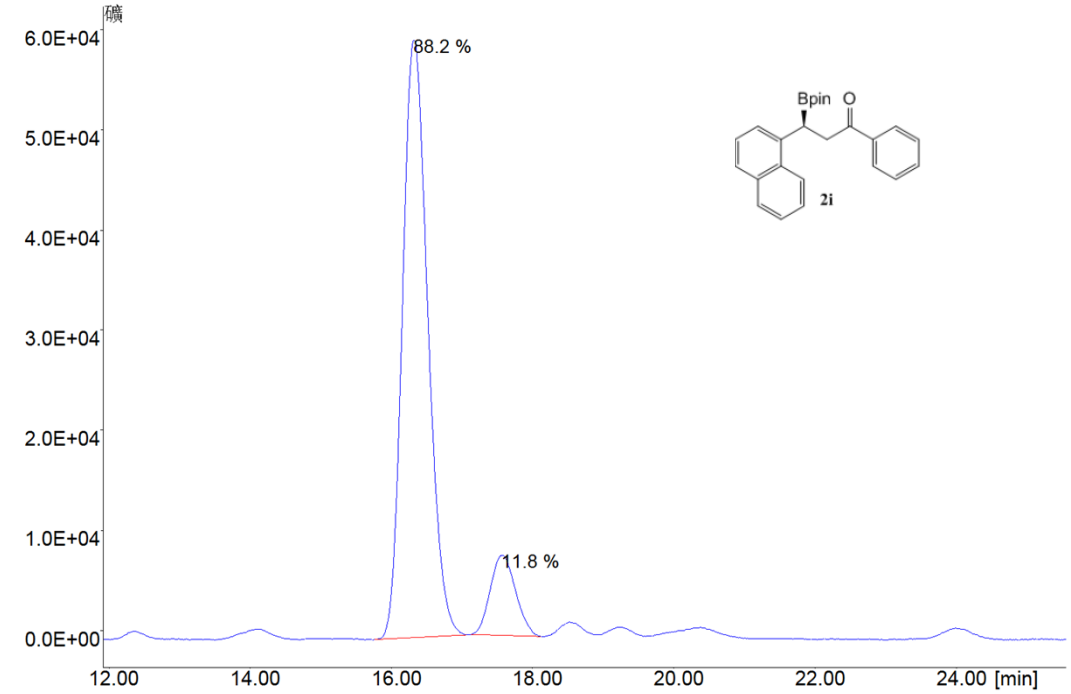

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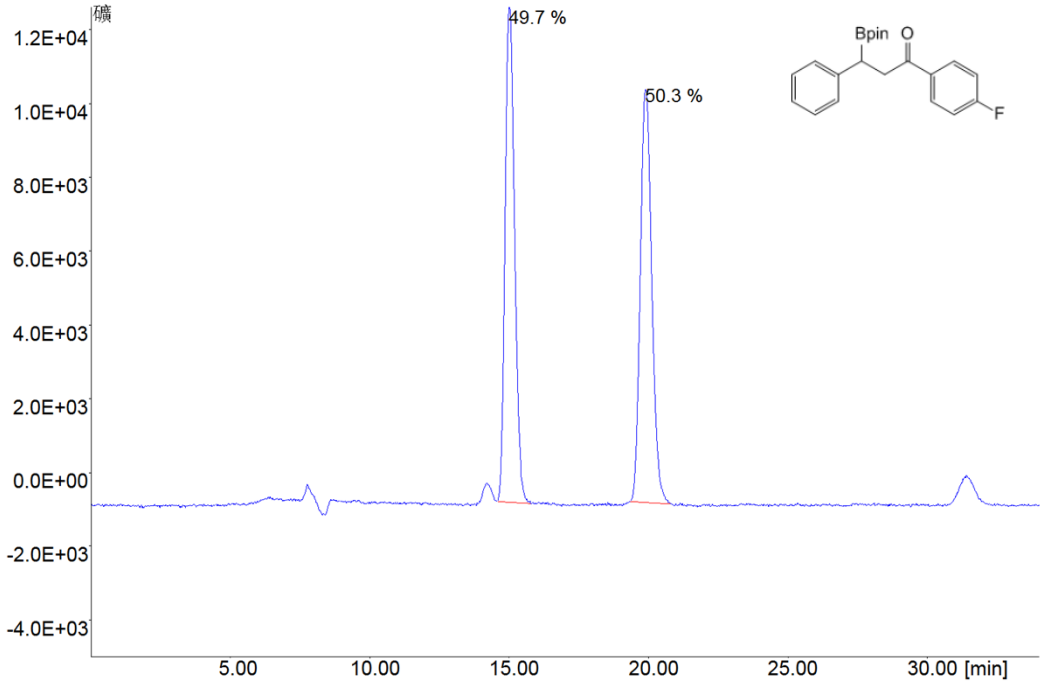

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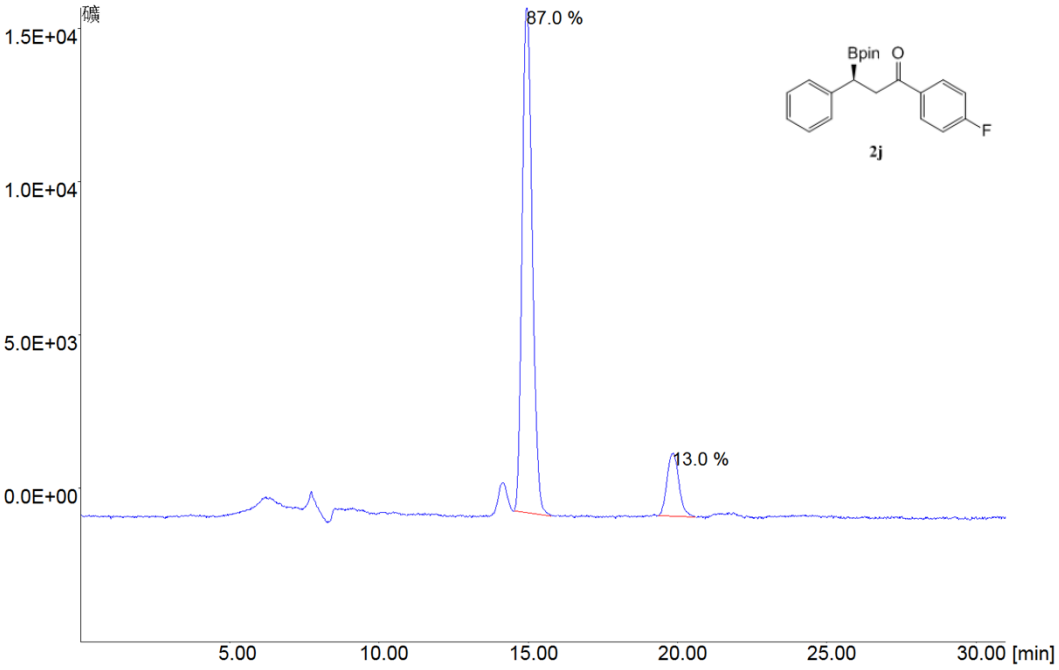

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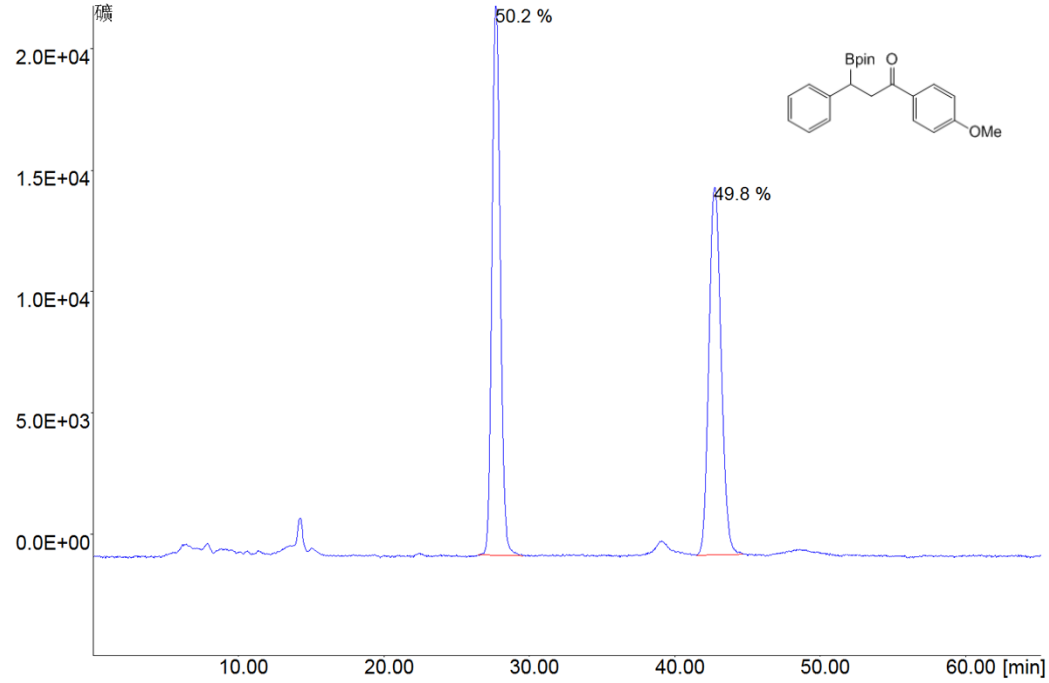

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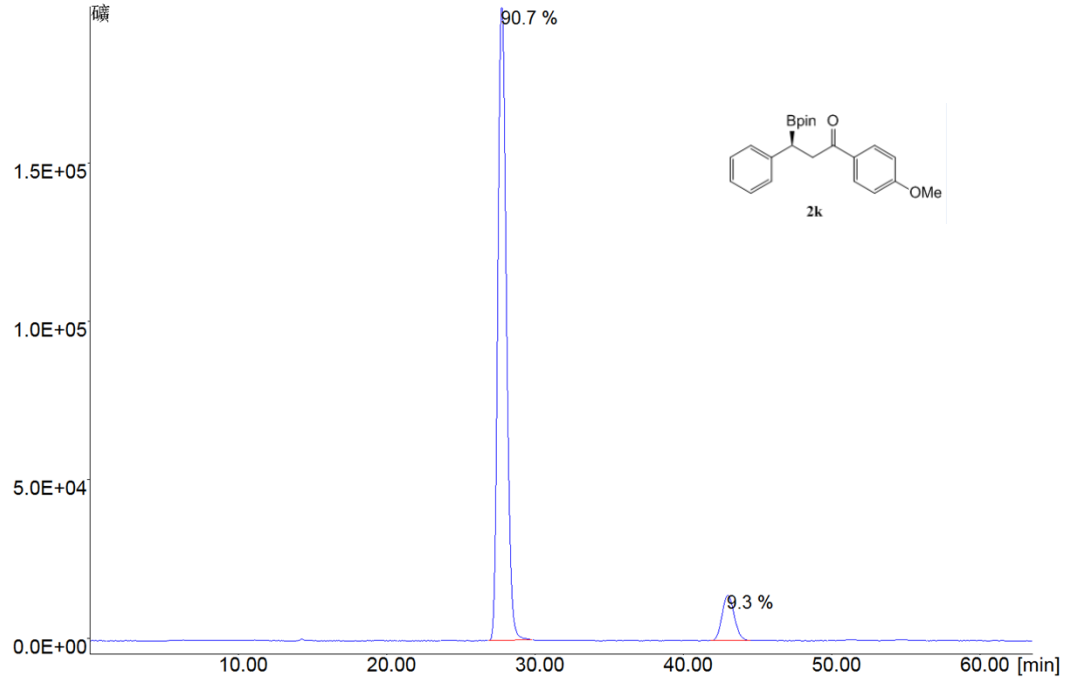

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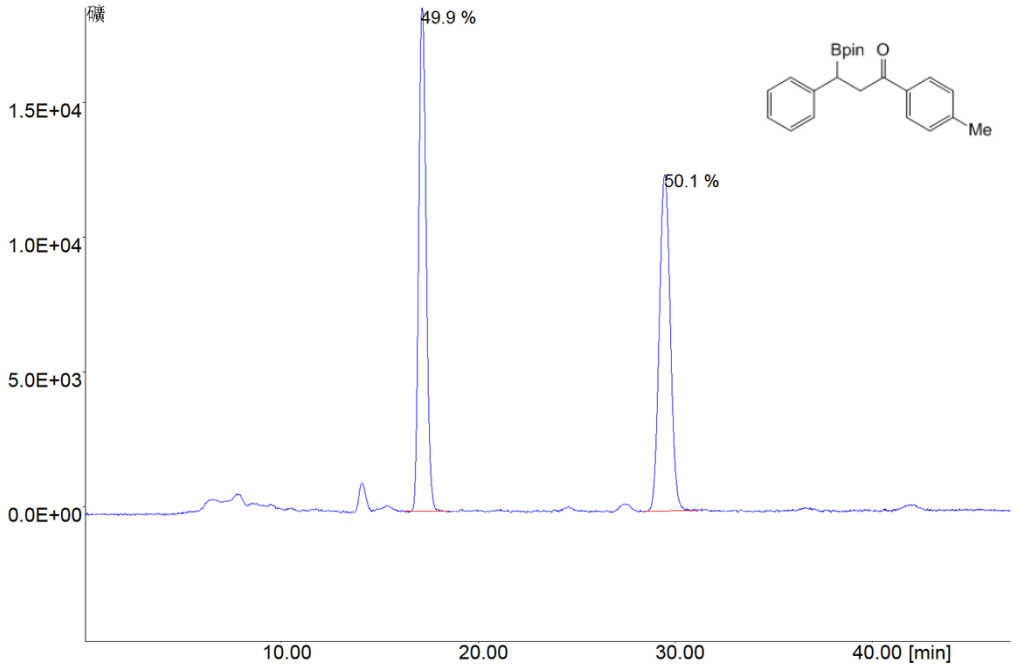

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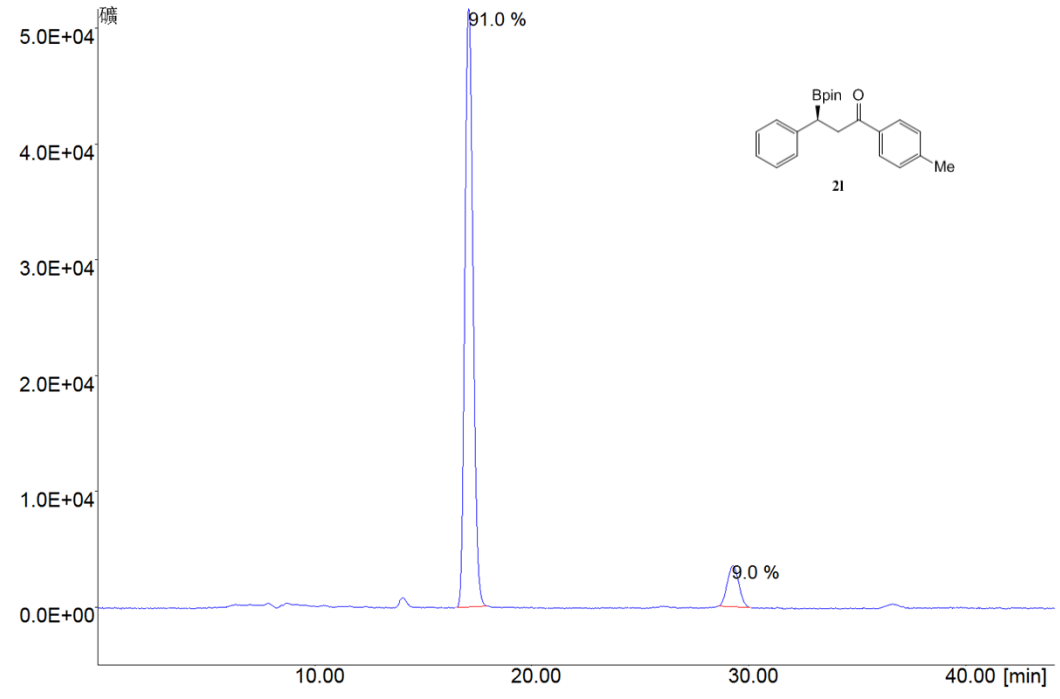

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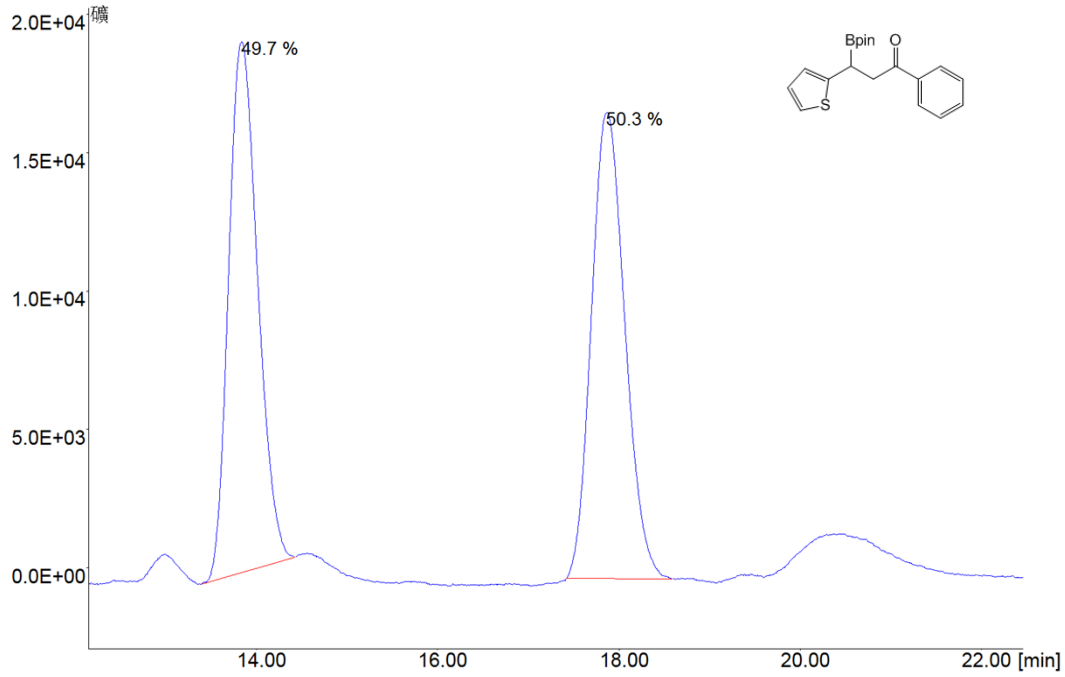

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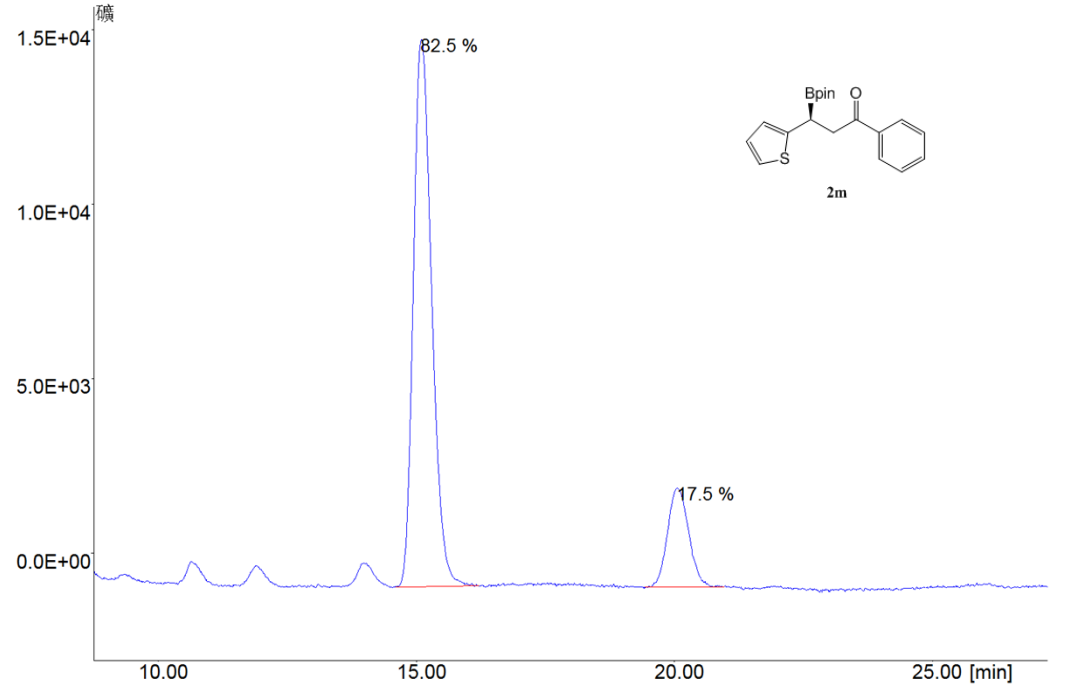

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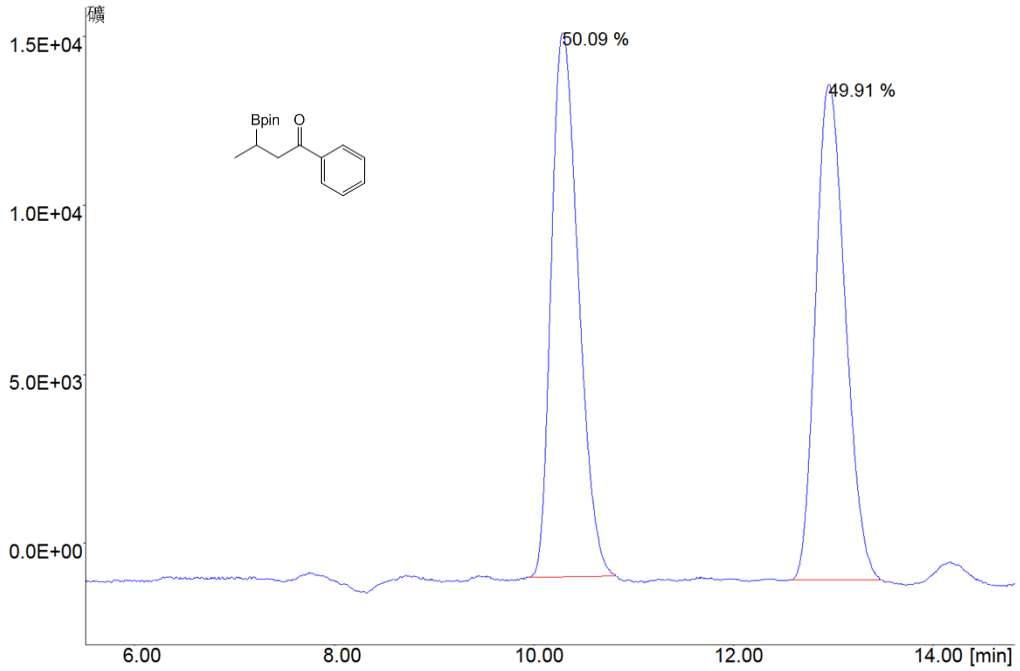

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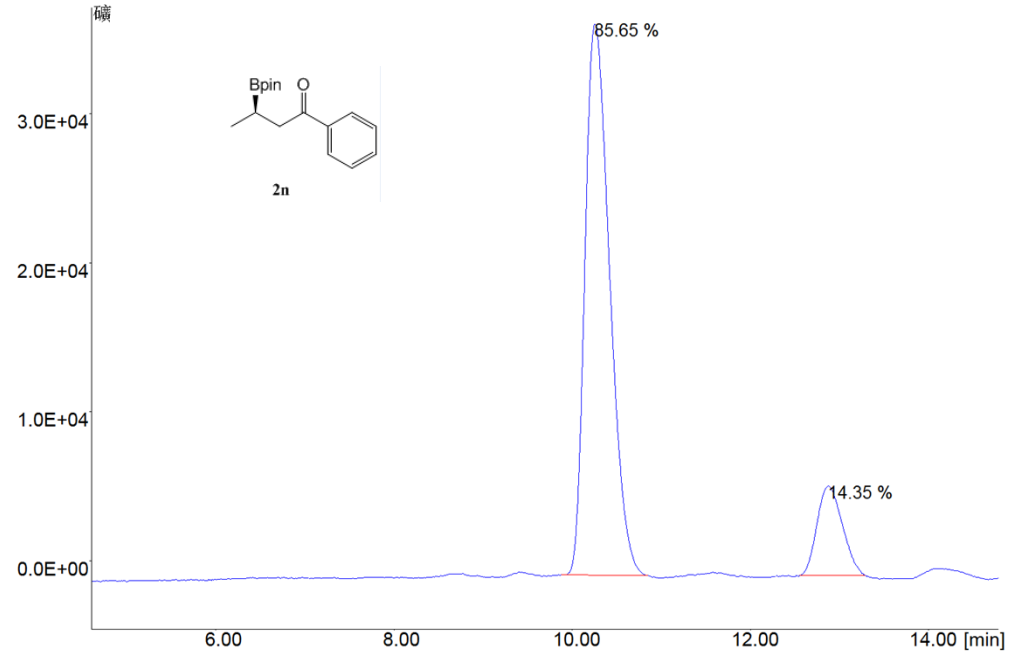

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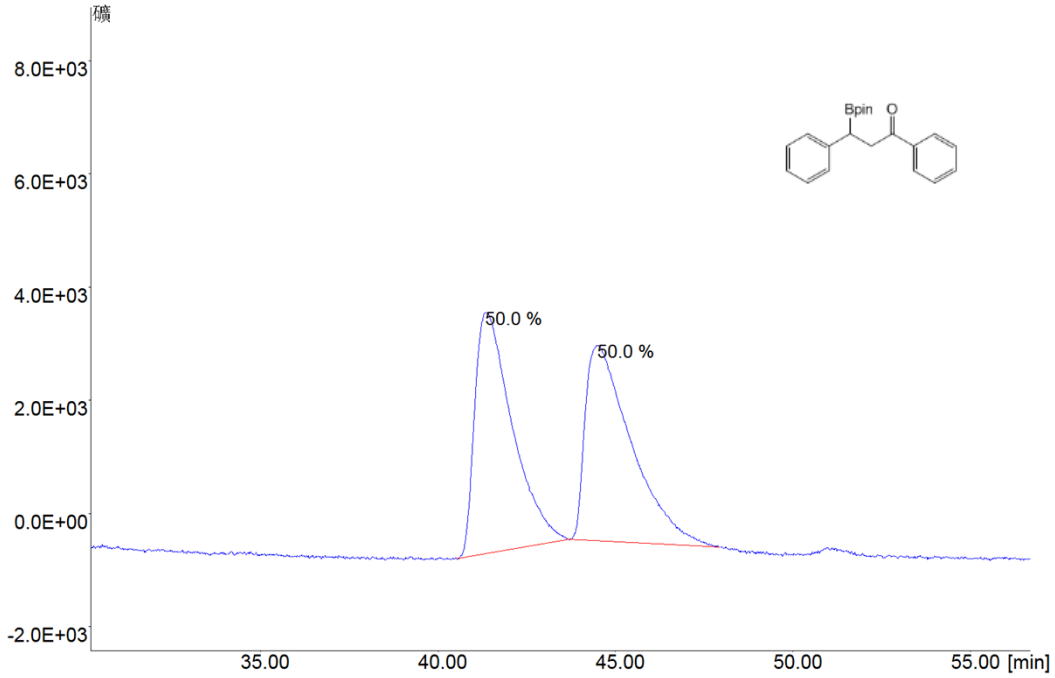
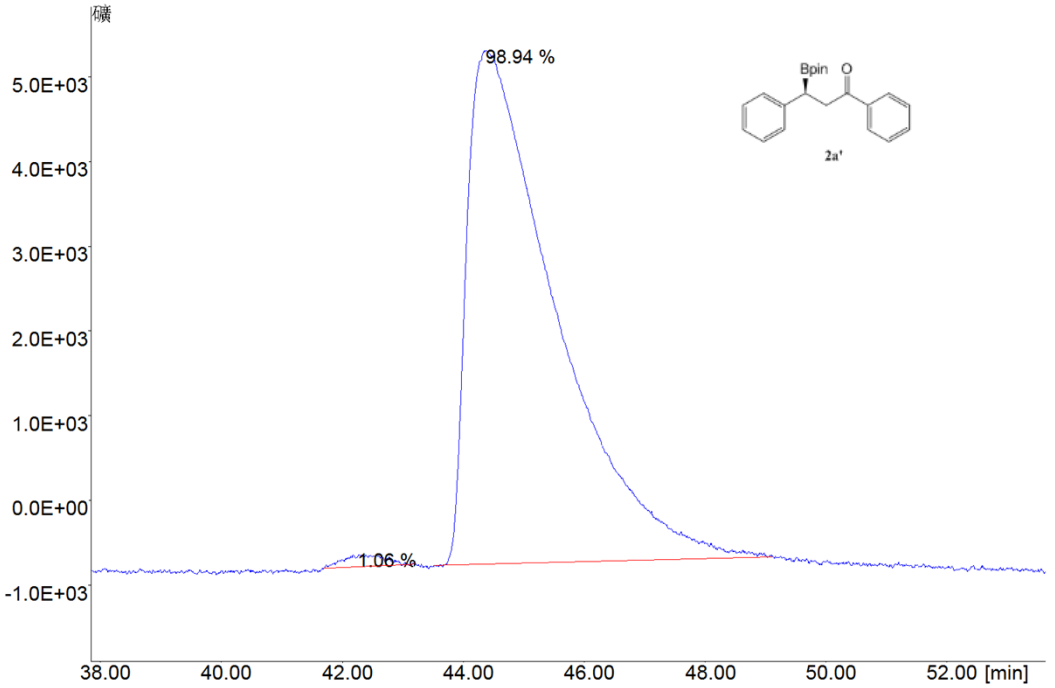
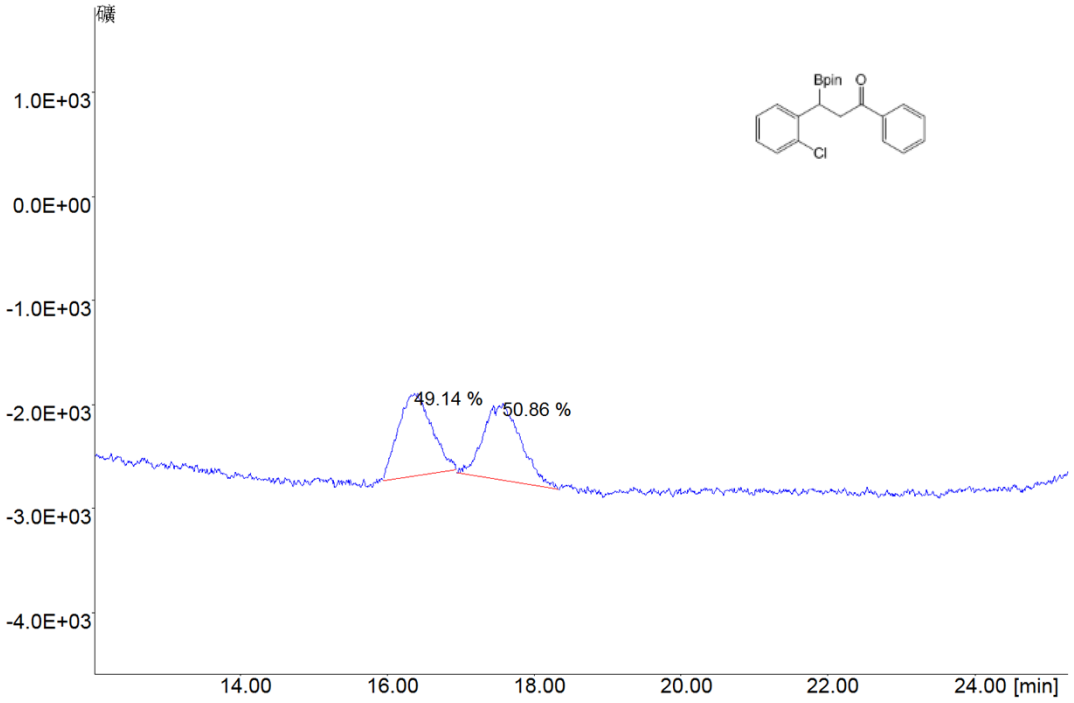
2		12.873	5991	117192.700	14.353



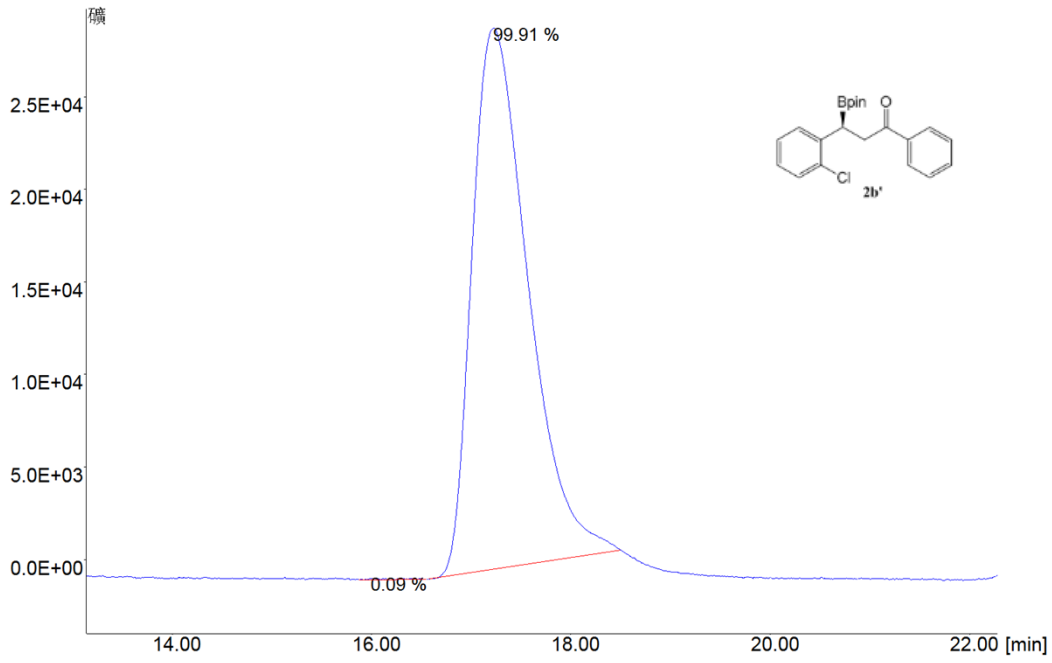
#	Name	RT	Height	Area[Sec]	%Area
1		41.357	4263	309971.587	49.994
2		44.507	3455	310042.474	50.006



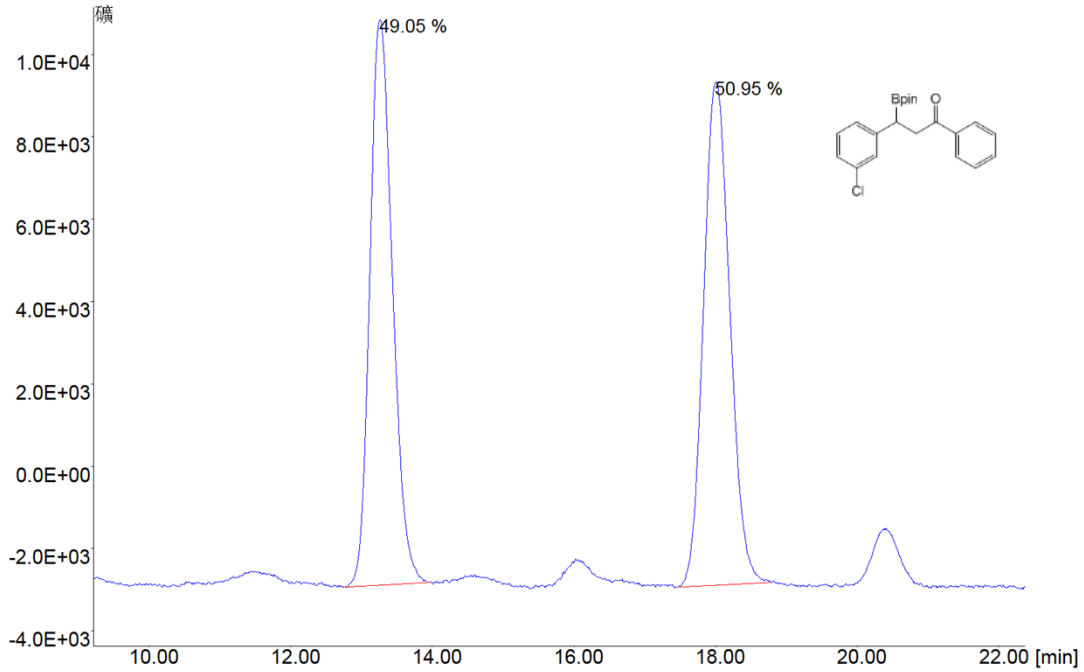
#	Name	RT	Height	Area[Sec]	%Area
1		42.267	149	6555.869	1.056
2		44.373	6067	614293.040	98.944



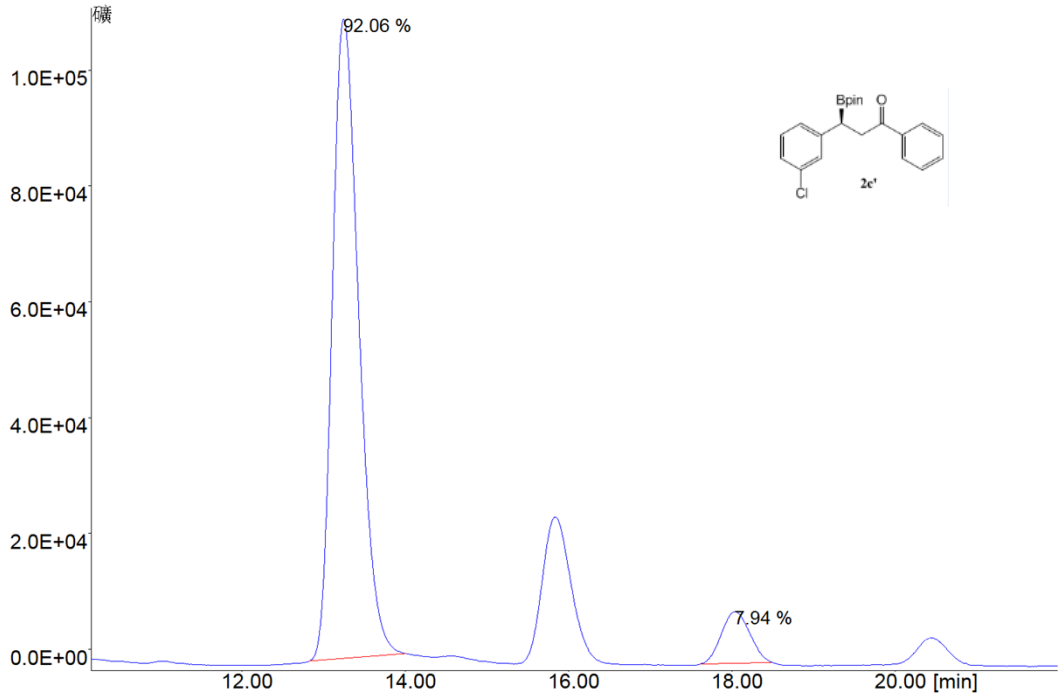
#	Name	RT	Height	Area[Sec]	%Area
1		16.373	801	25131.427	49.141
2		17.573	741	26009.922	50.859



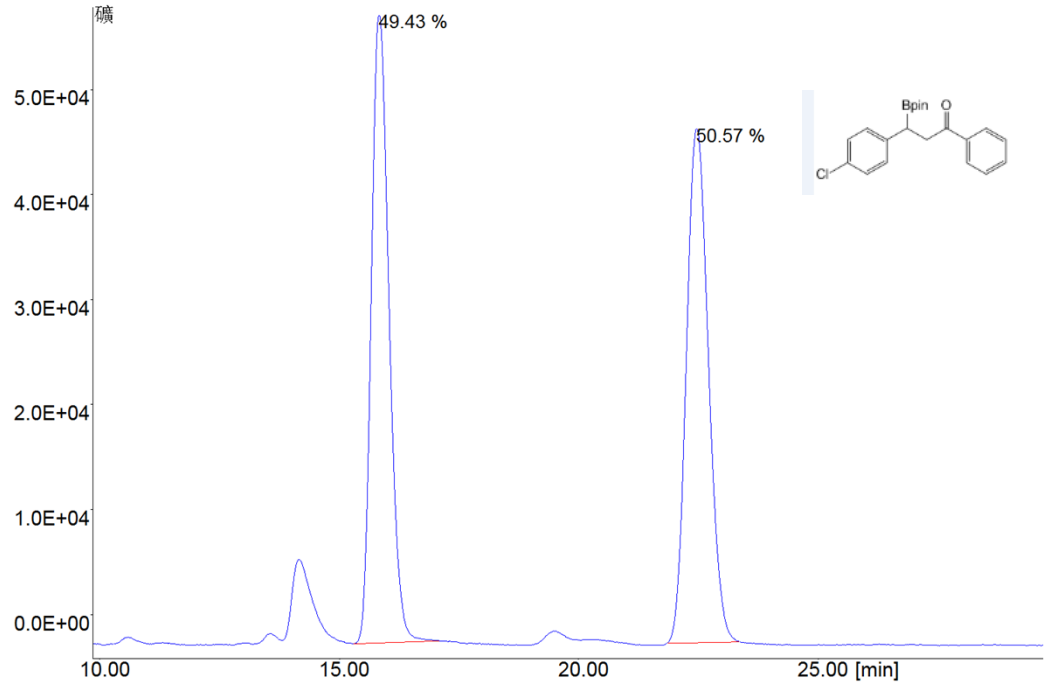
#	Name	RT	Height	Area[Sec]	%Area
1		15.997	69	1015.032	0.089
2		17.227	29235	1134052.492	99.911



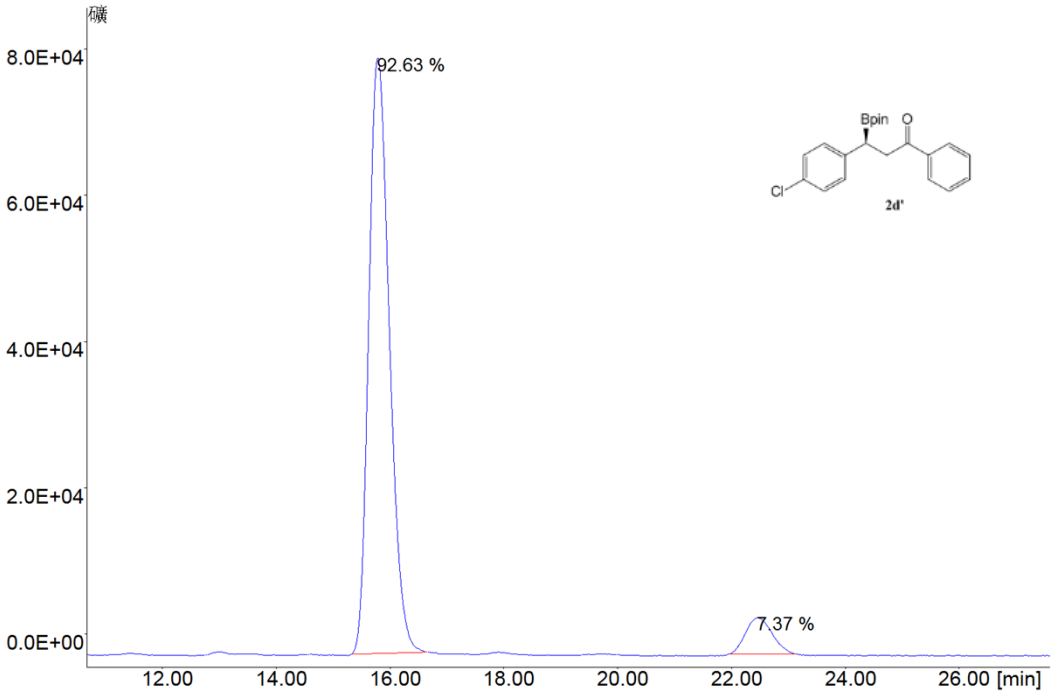
#	Name	RT	Height	Area[Sec]	%Area
1		13.263	13727	300257.618	49.048
2		18.003	12221	311908.386	50.952



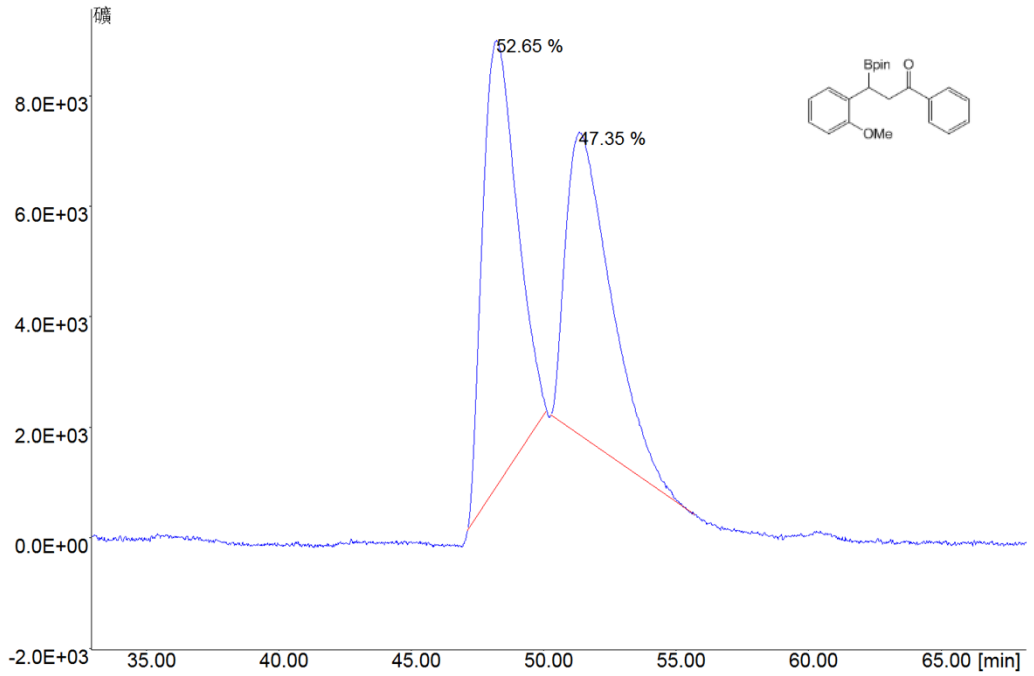
#	Name	RT	Height	Area[Sec]	%Area
1		13.247	110359	2454691.200	92.064
2		18.040	8867	211594.400	7.936



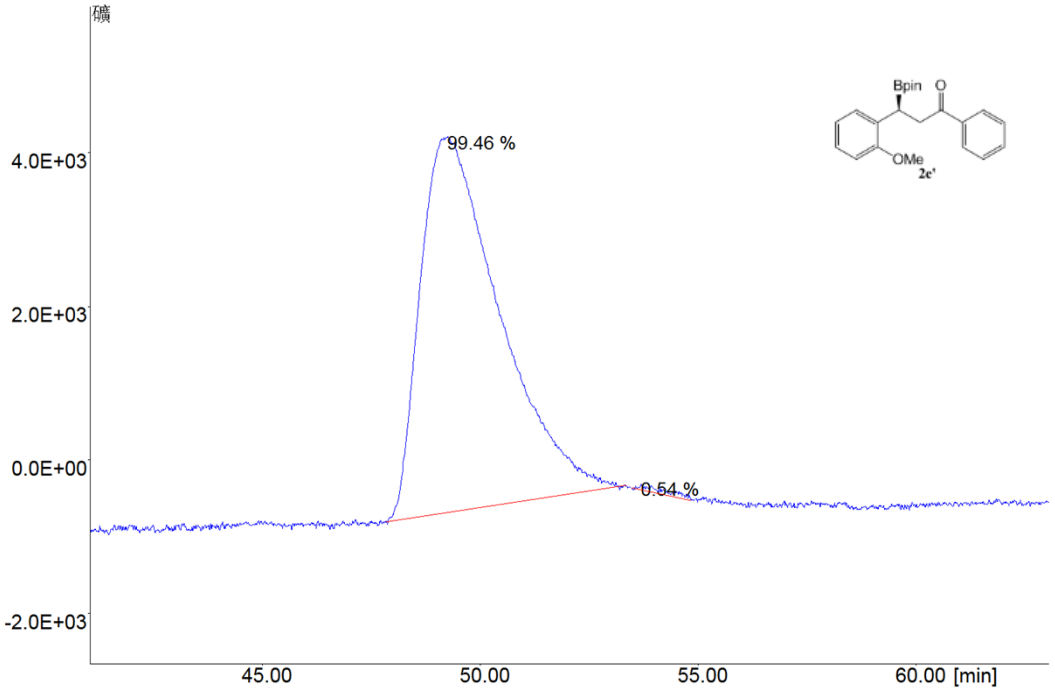
#	Name	RT	Height	Area[Sec]	%Area
1		15.830	59759	1498430.106	49.429
2		22.460	48919	1533060.732	50.571



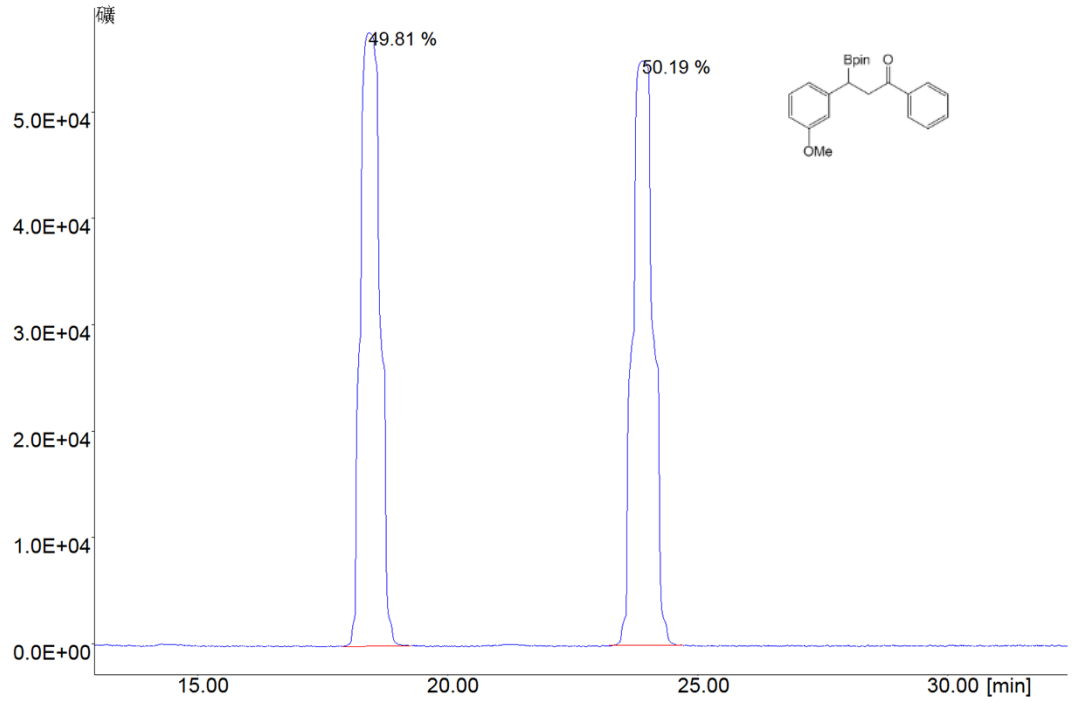
#	Name	RT	Height	Area[Sec]	%Area
1		15.780	81331	2006990.892	92.629
2		22.450	4962	159697.500	7.371



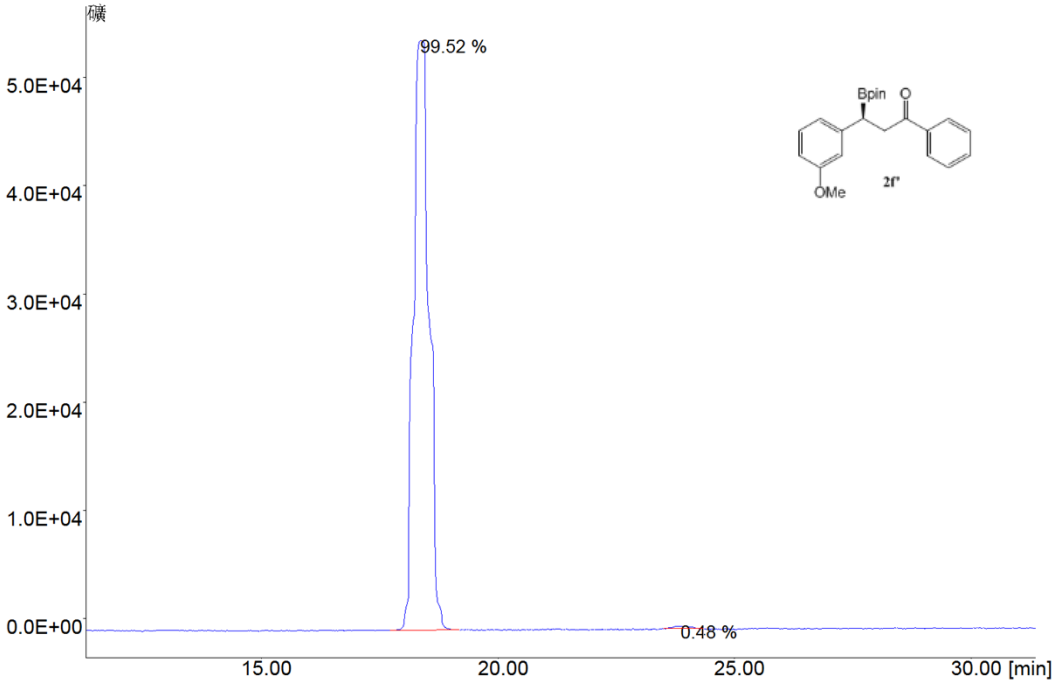
#	Name	RT	Height	Area[Sec]	%Area
1		48.207	8090	722136.400	52.654
2		51.333	5474	649344.574	47.346



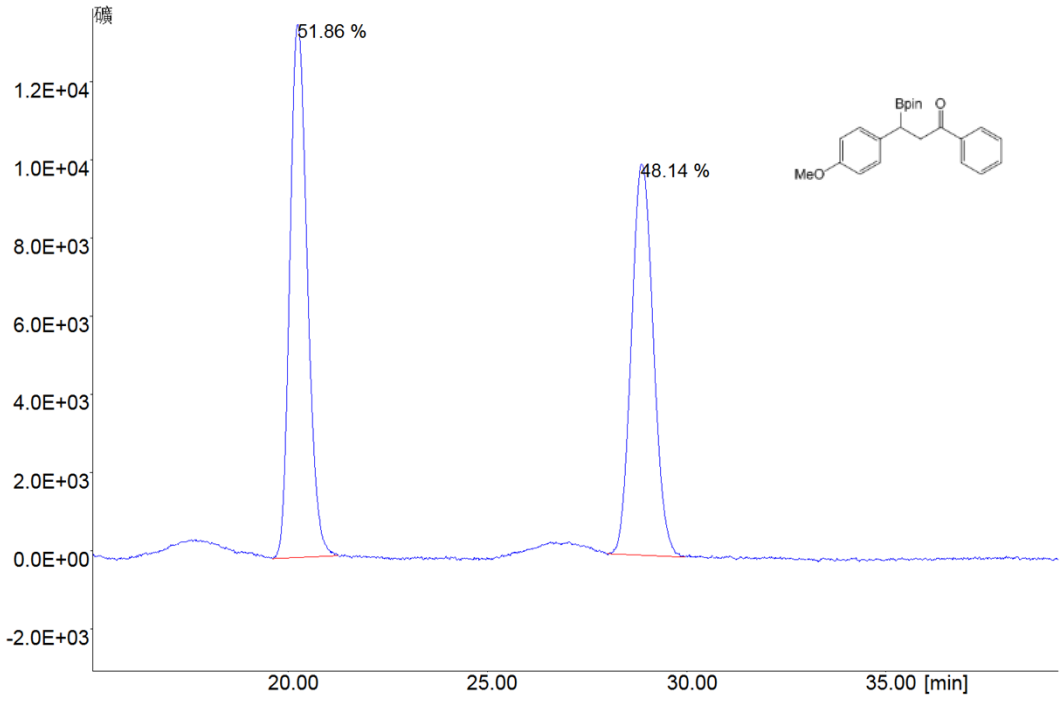
#	Name	RT	Height	Area[Sec]	%Area
1		49.250	4893	614480.374	99.457
2		53.700	82	3353.602	0.543



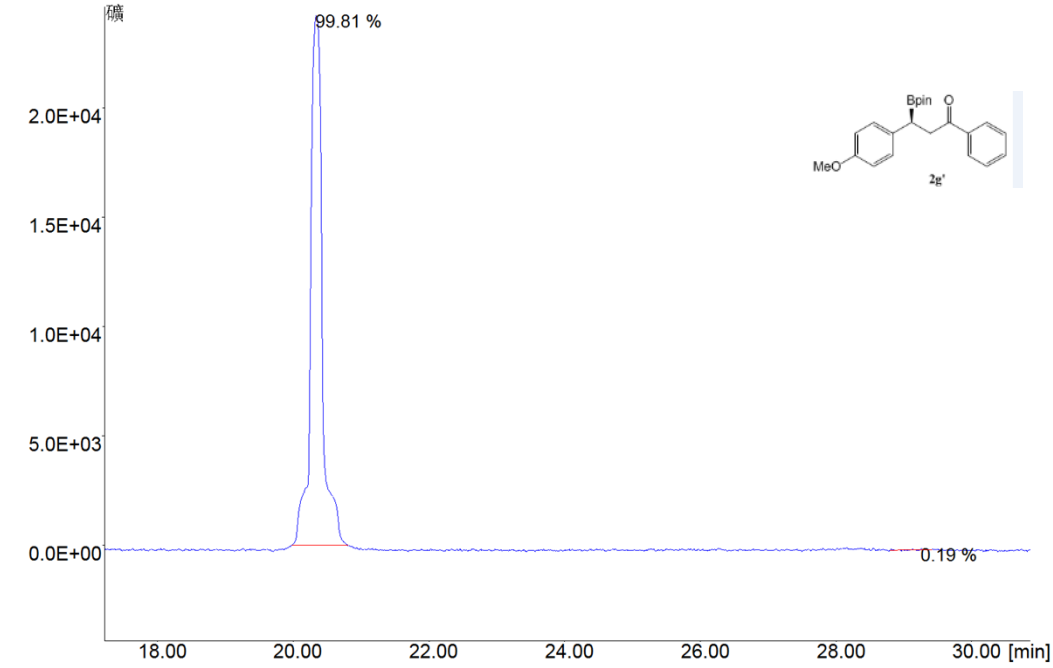
#	Name	RT	Height	Area[Sec]	%Area
1		18.423	57700	1551762.462	49.808
2		23.890	54967	1563739.238	50.192



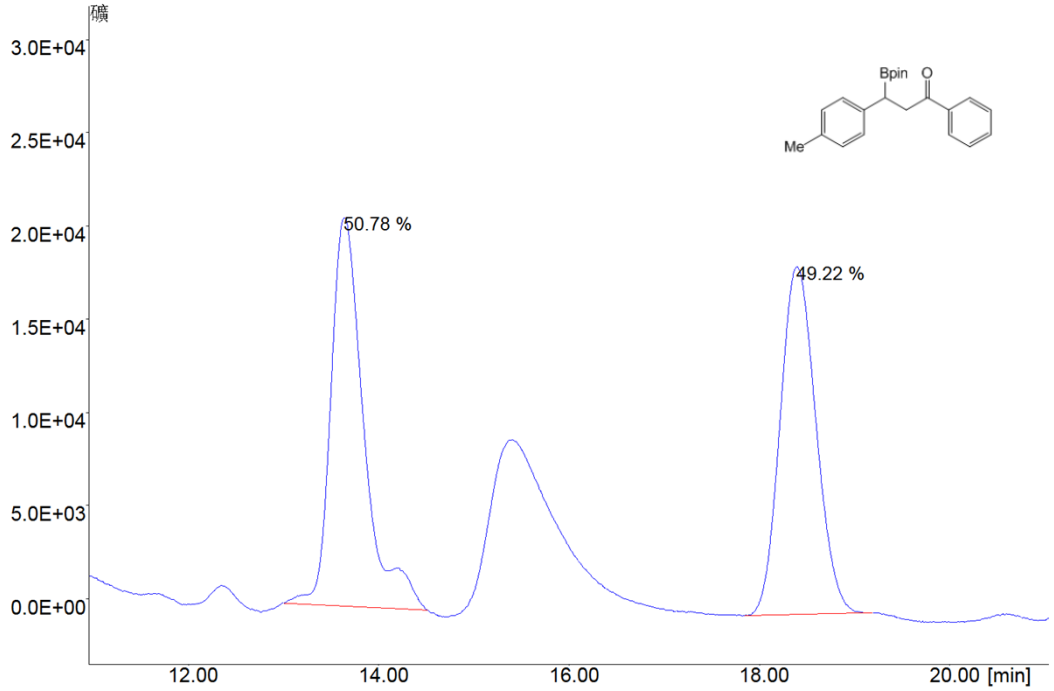
#	Name	RT	Height	Area[Sec]	%Area
1		18.363	54503	1233430.087	99.524
2		23.870	233	5894.583	0.476



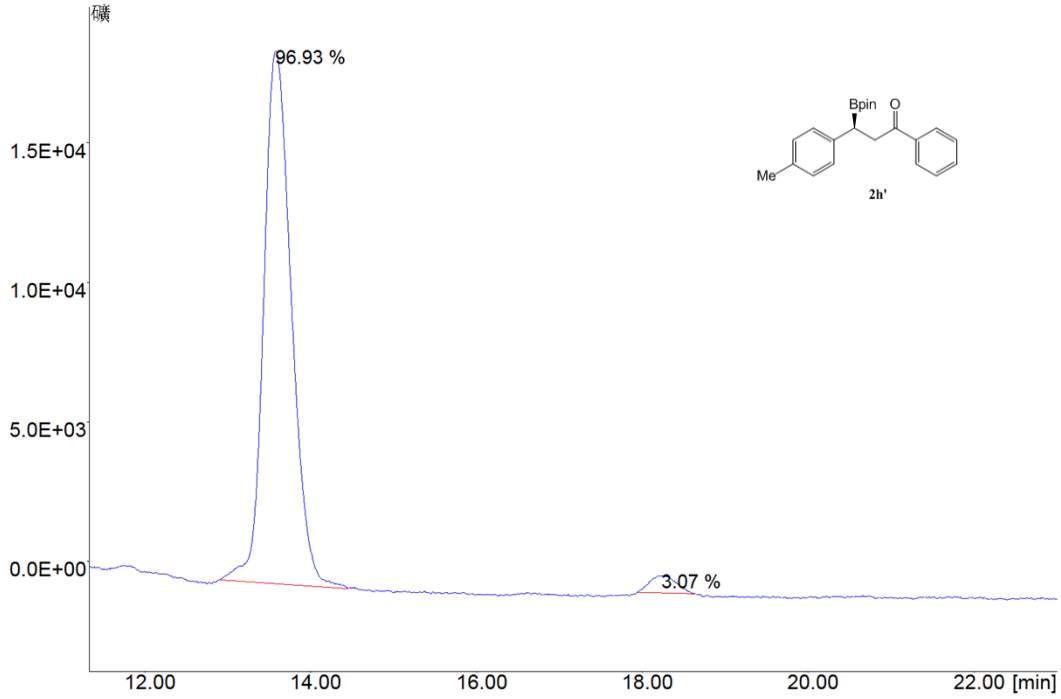
#	Name	RT	Height	Area[Sec]	%Area
1		20.237	13631	405115.200	51.859
2		28.857	9997	376067.407	48.141



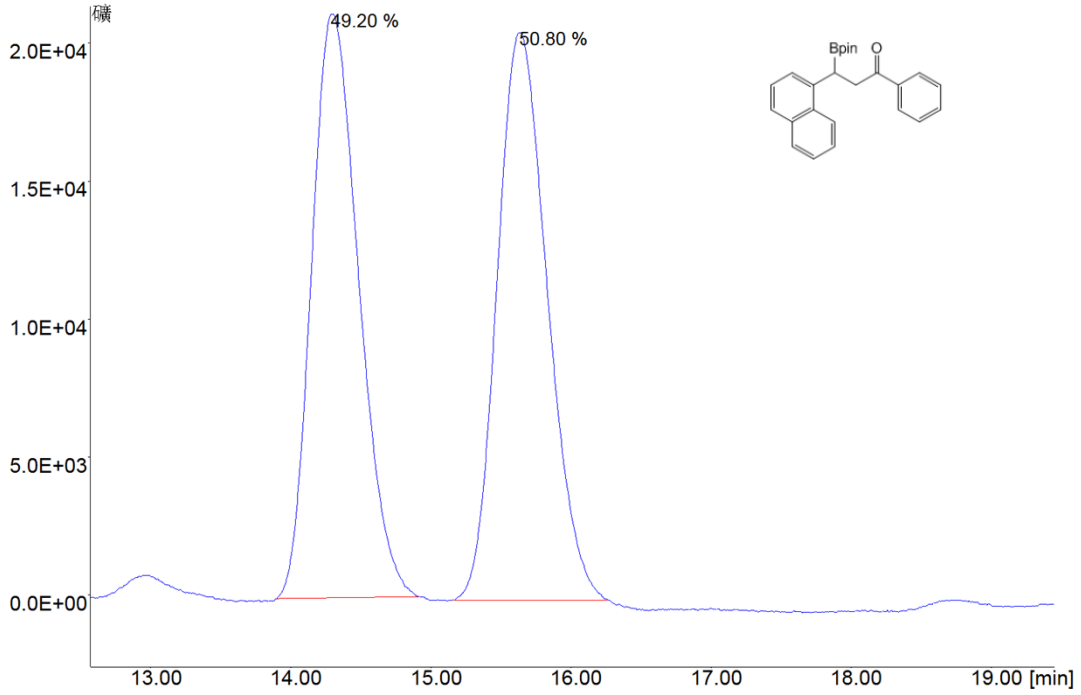
#	Name	RT	Height	Area[Sec]	%Area
1		20.333	24247	281309.927	99.806
2		29.253	66	546.409	0.194



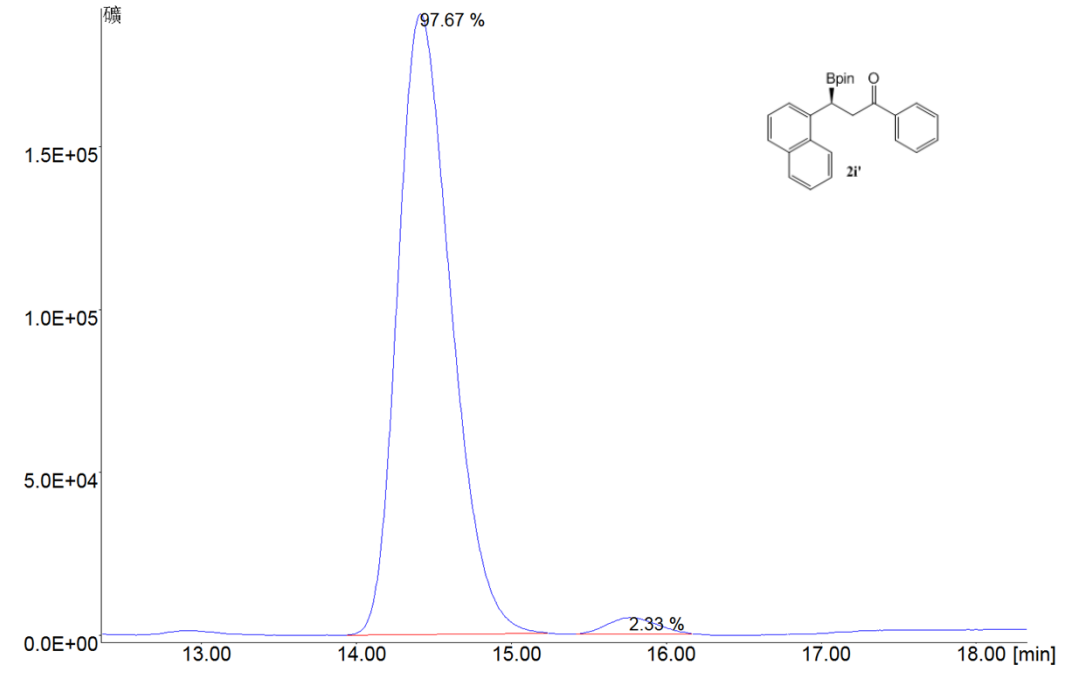
#	Name	RT	Height	Area[Sec]	%Area
1		13.637	20822	496308.897	50.778
2		18.393	18632	481093.881	49.222



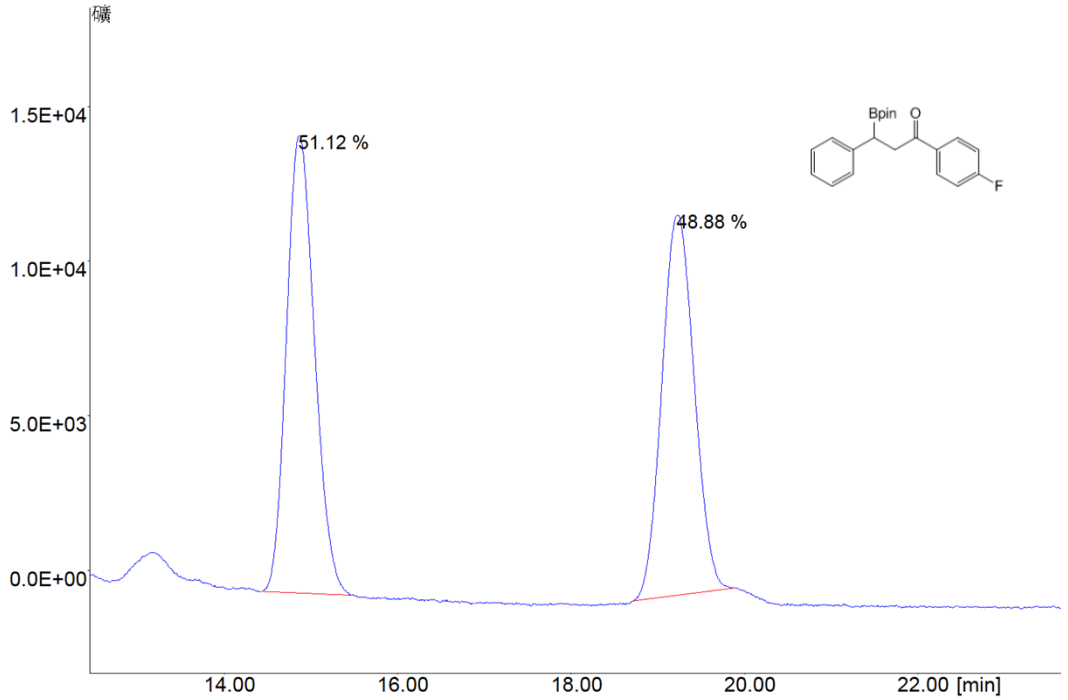
#	Name	RT	Height	Area[Sec]	%Area
1		13.580	19096	435606.610	96.925
2		18.233	625	13819.049	3.075



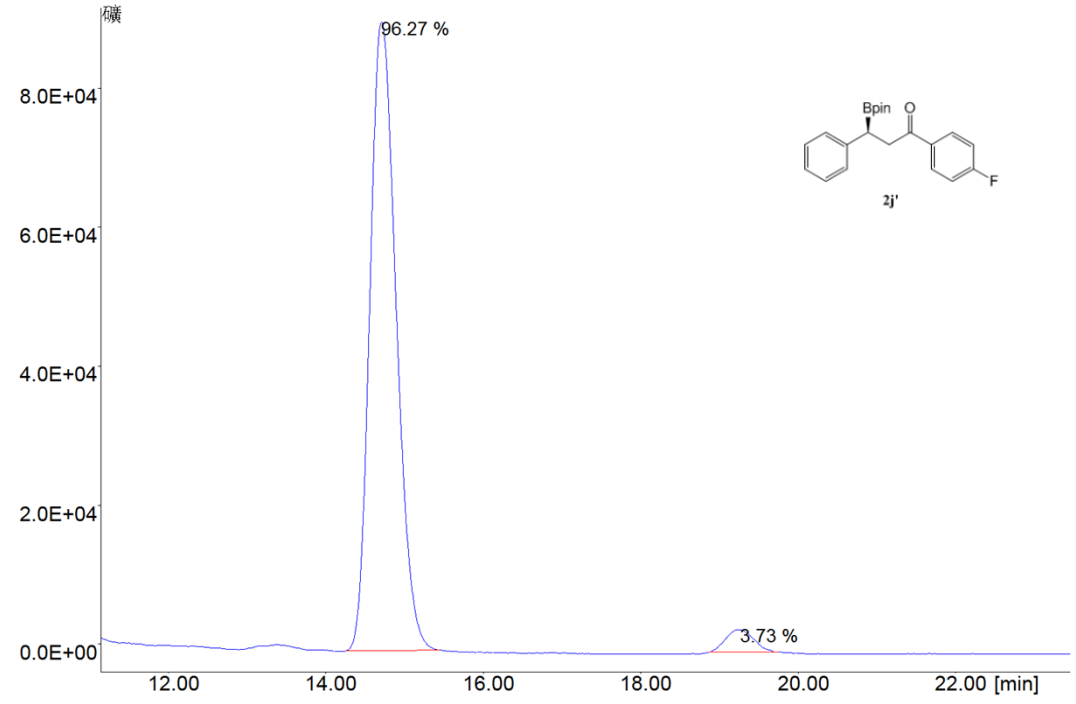
#	Name	RT	Height	Area[Sec]	%Area
1		14.290	21153	490654.851	49.196
2		15.633	20551	506682.815	50.804



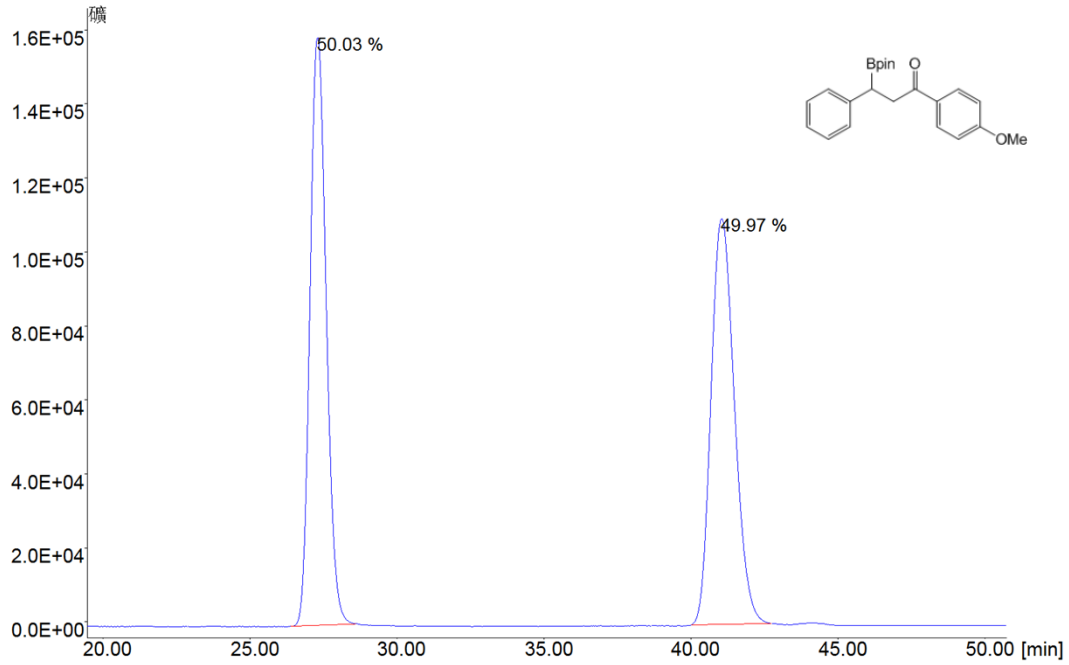
#	Name	RT	Height	Area[Sec]	%Area
1		14.410	190693	4562421.200	97.672
2		15.760	4960	108748.903	2.328



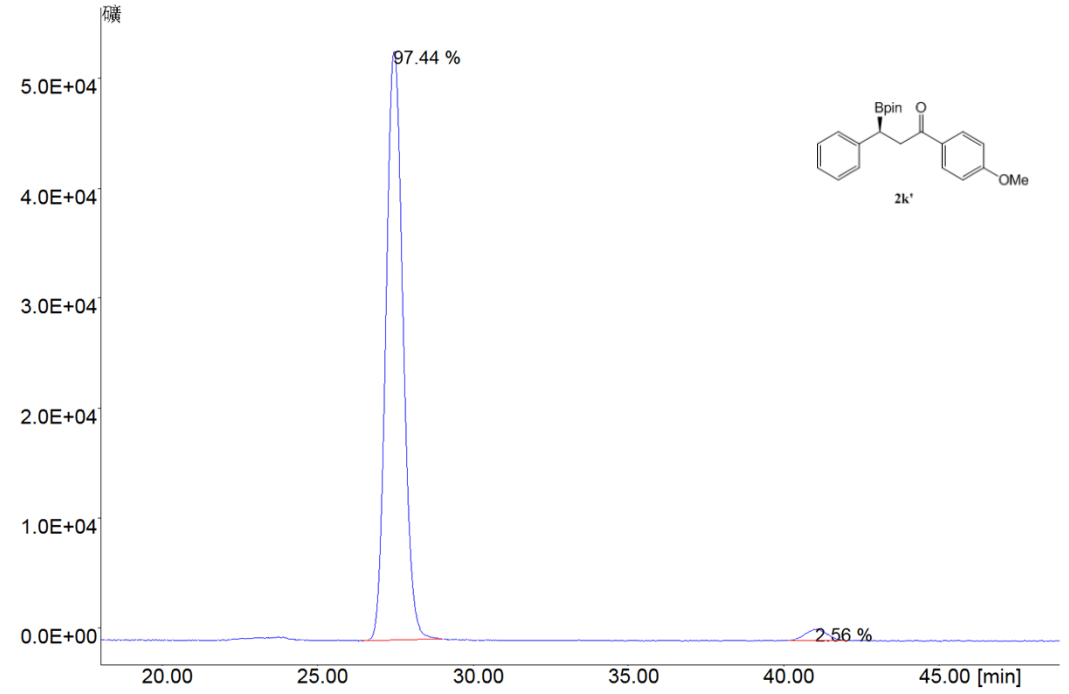
#	Name	RT	Height	Area[Sec]	%Area
1		14.860	14782	328504.904	51.121
2		19.217	12287	314099.842	48.879



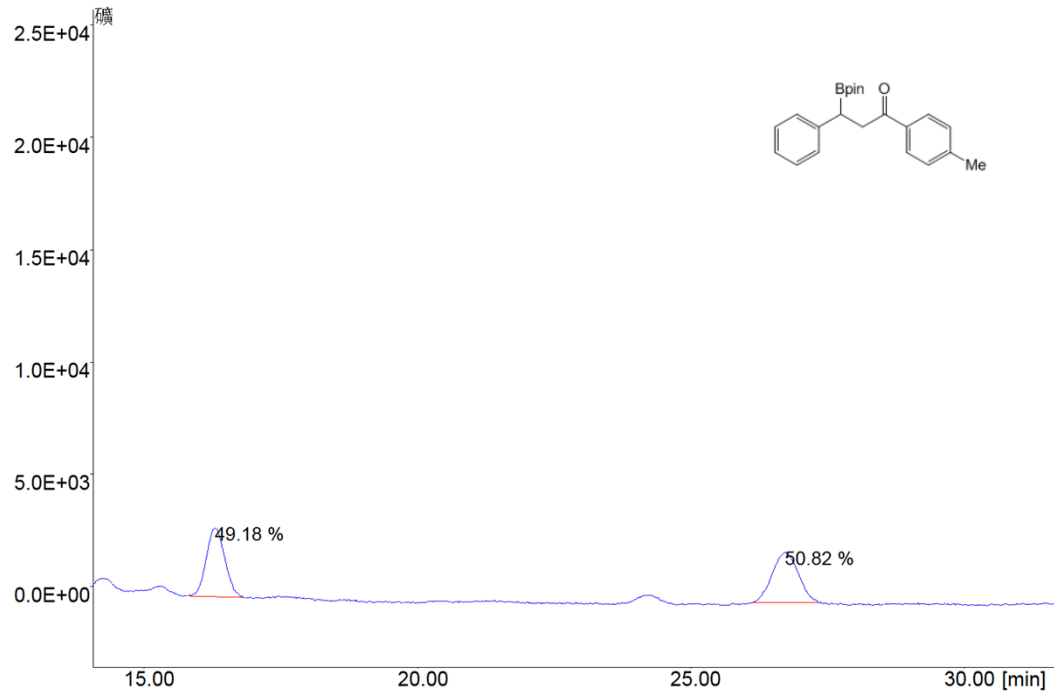
#	Name	RT	Height	Area[Sec]	%Area
1		14.707	90393	2063812.800	96.266
2		19.260	3255	80042.200	3.734



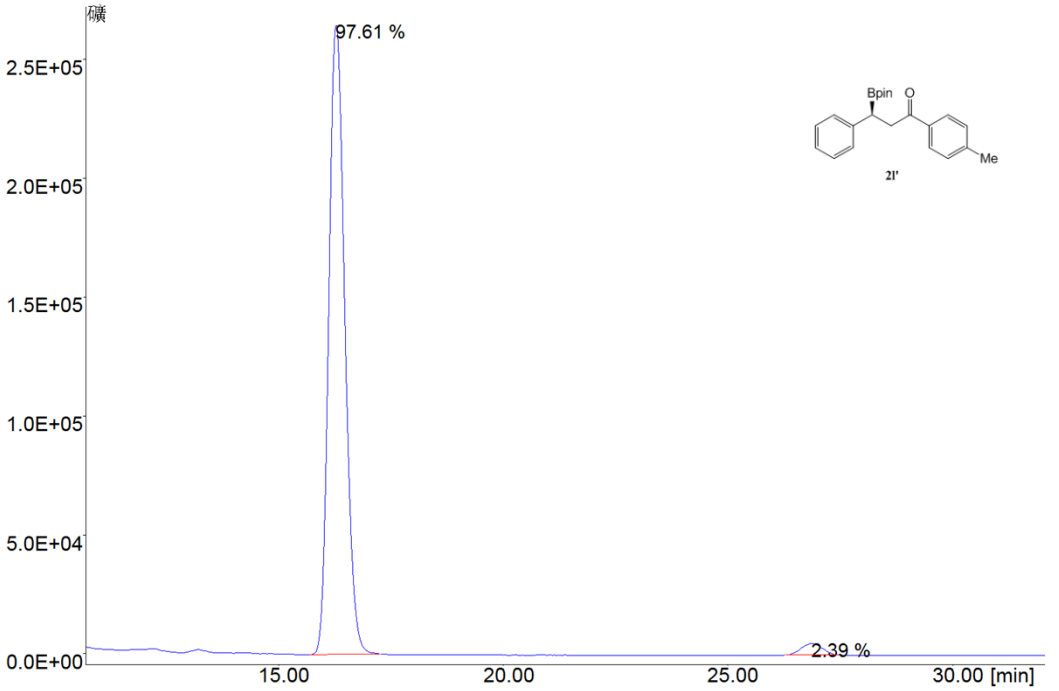
#	Name	RT	Height	Area[Sec]	%Area
1		27.293	158984	5953097.153	50.026
2		41.030	109644	5946795.439	49.974



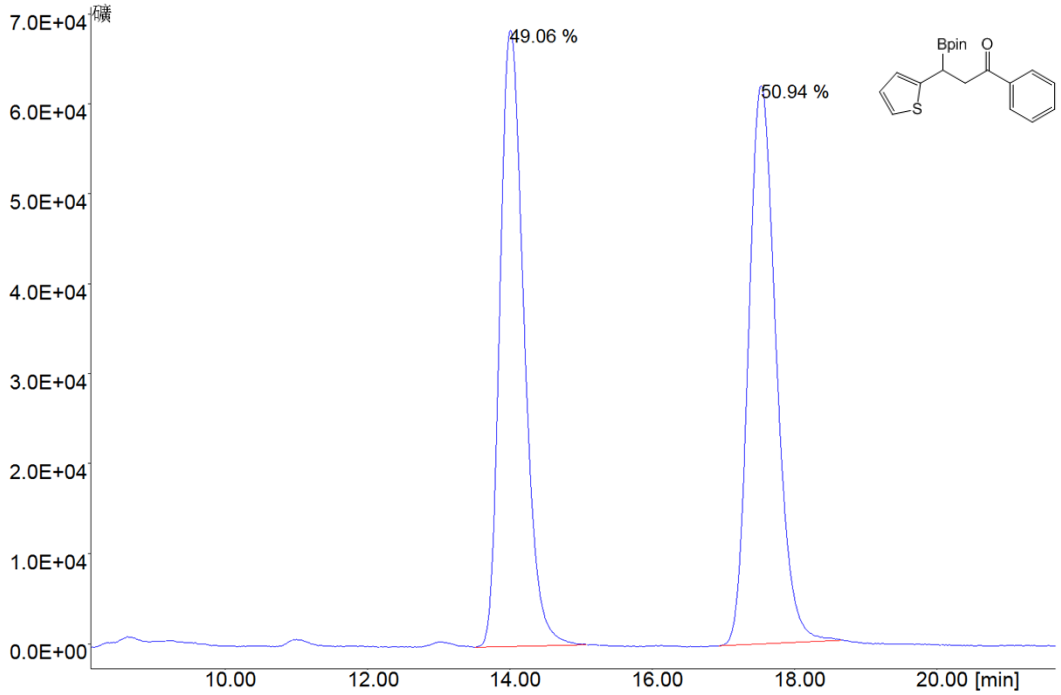
#	Name	RT	Height	Area[Sec]	%Area
1		27.460	53525	1991170.183	97.439
2		41.033	1077	52340.400	2.561



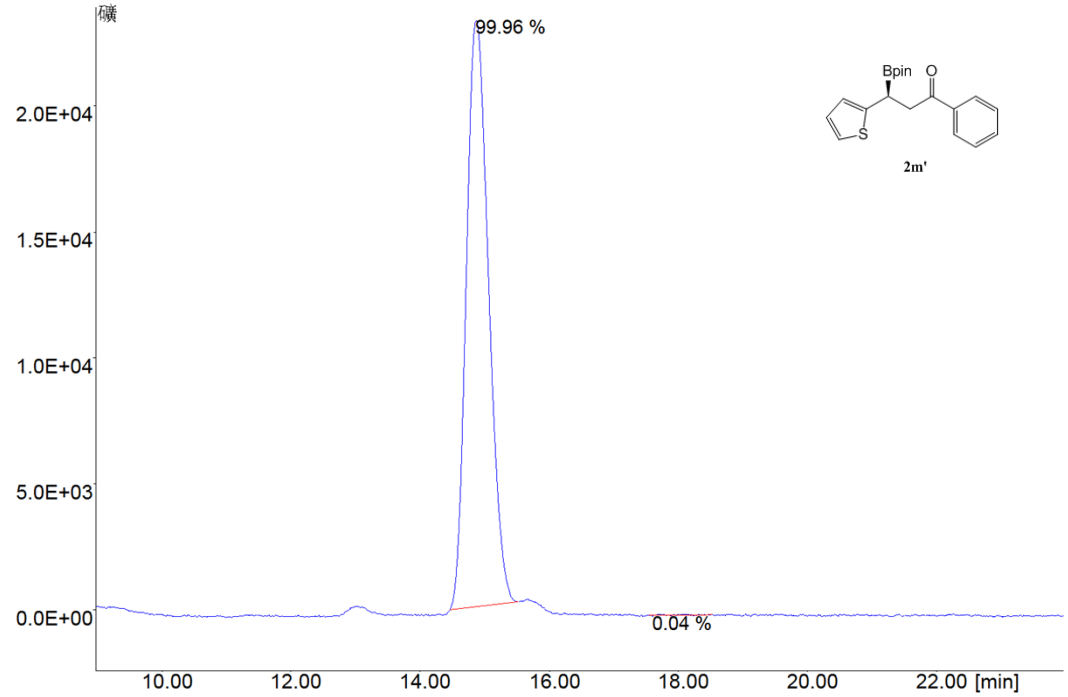
#	Name	RT	Height	Area[Sec]	%Area
1		16.297	3055	70903.448	49.179
2		26.733	2225	73269.800	50.821



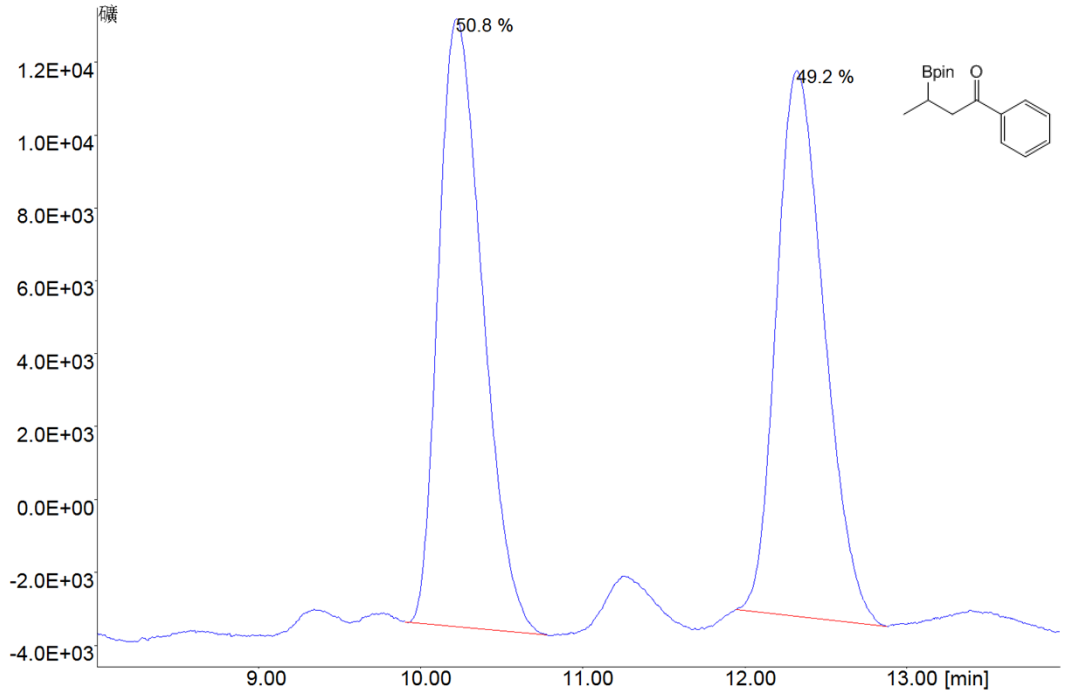
#	Name	RT	Height	Area[Sec]	%Area
1		16.277	264559	6376590.417	97.607
2		26.860	4805	156313.377	2.393



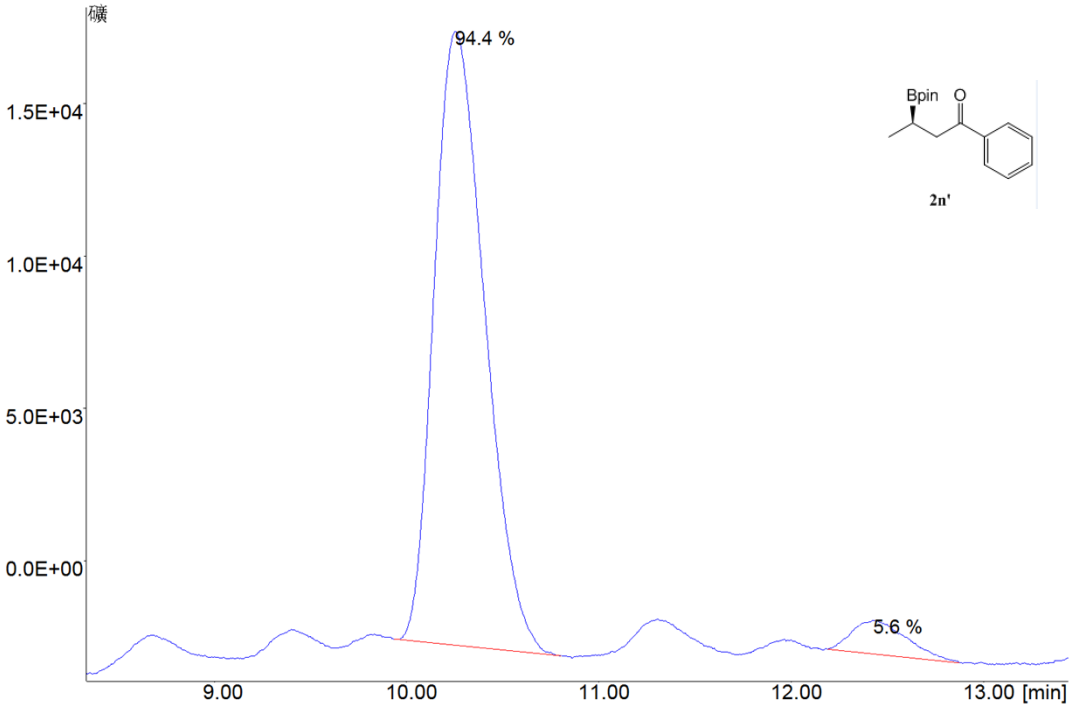
#	Name	RT	Height	Area[Sec]	%Area
1		14.003	68473	1581469.262	49.065
2		17.527	62044	1641754.982	50.935



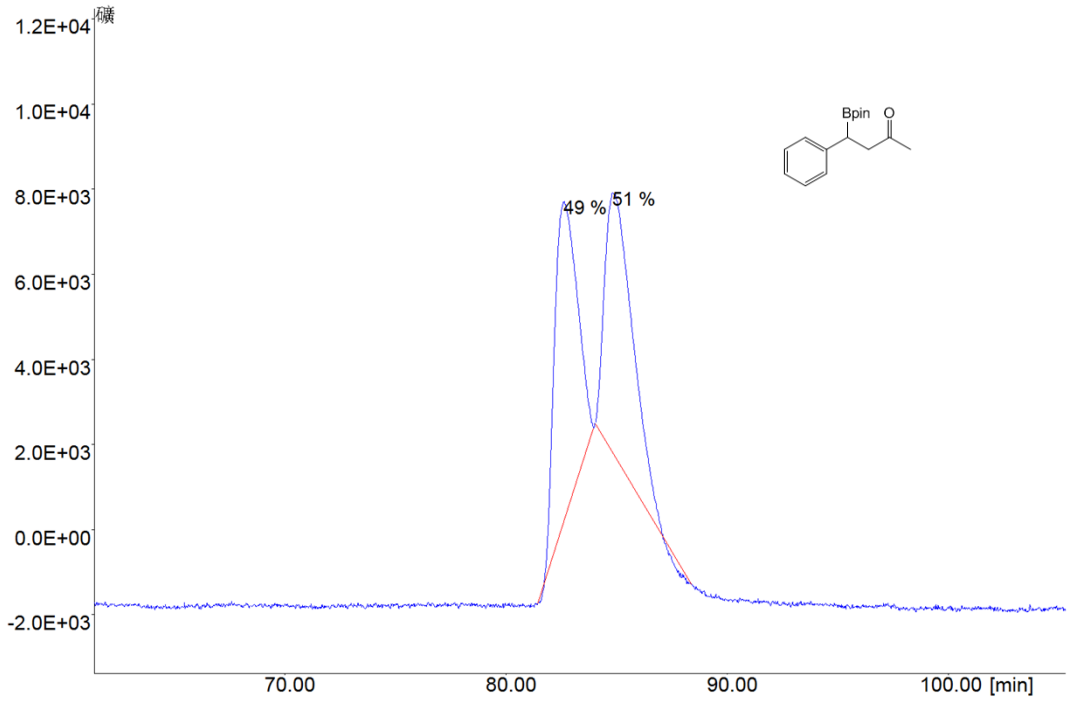
#	Name	RT	Height	Area[Sec]	%Area
1		14.867	23282	546904.575	99.957
2		17.600	52	236.801	0.043



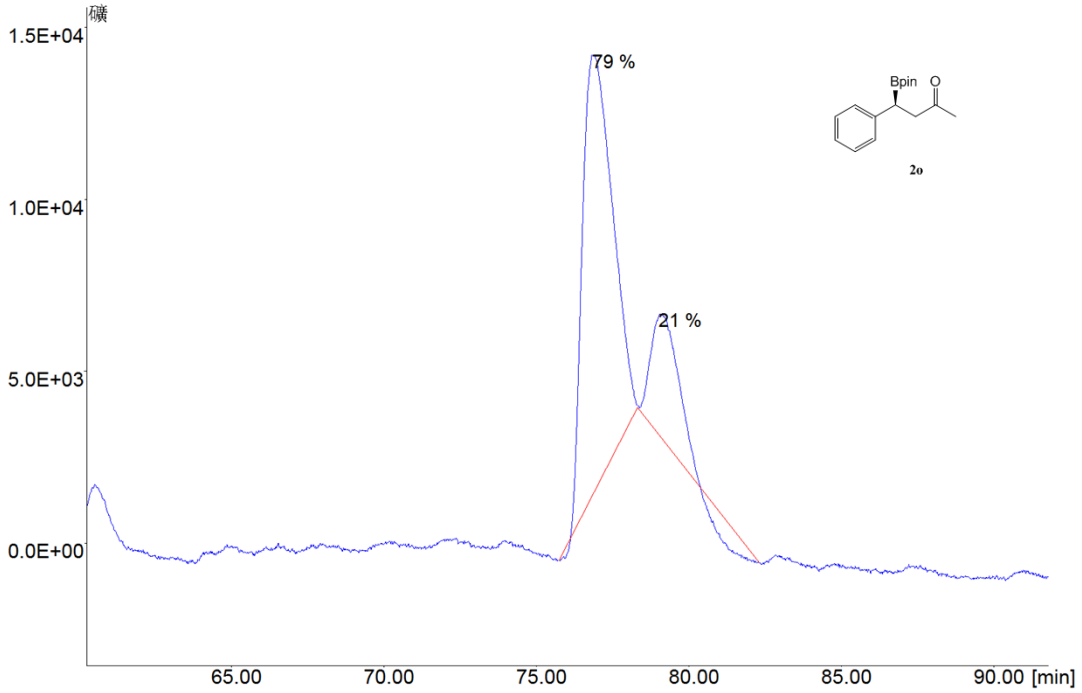
#	Name	RT	Height	Area[Sec]	%Area
1		10.223	16669	316211.435	50.757
2		12.320	14976	306777.389	49.243



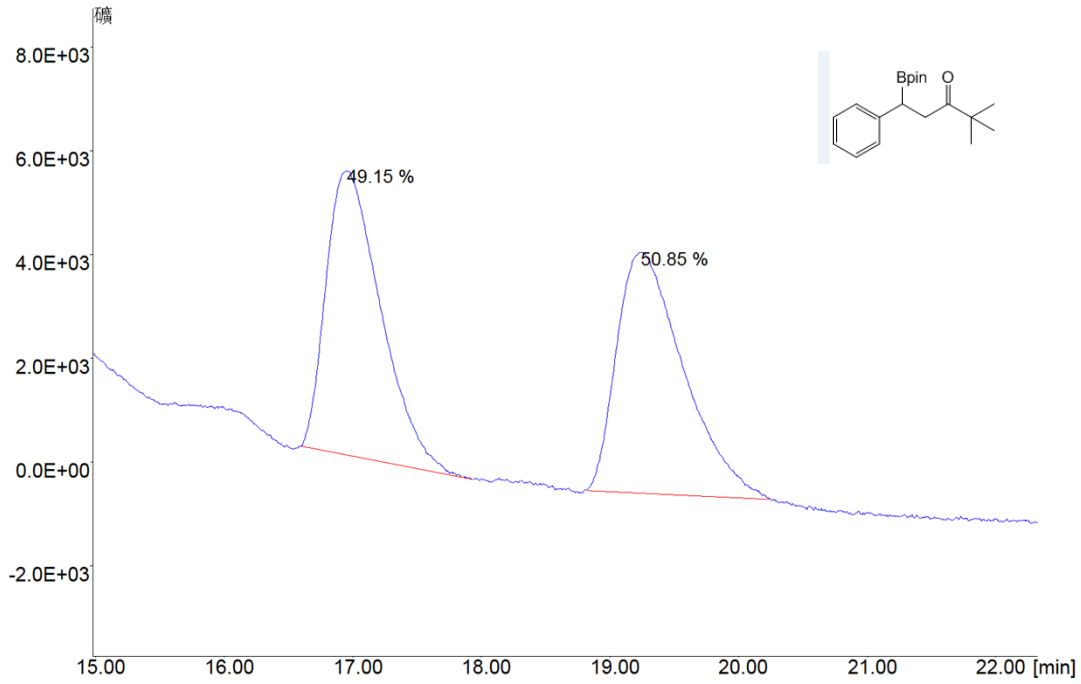
#	Name	RT	Height	Area[Sec]	%Area
1		10.253	20125	369171.385	94.421
2		12.430	1097	21811.600	5.579



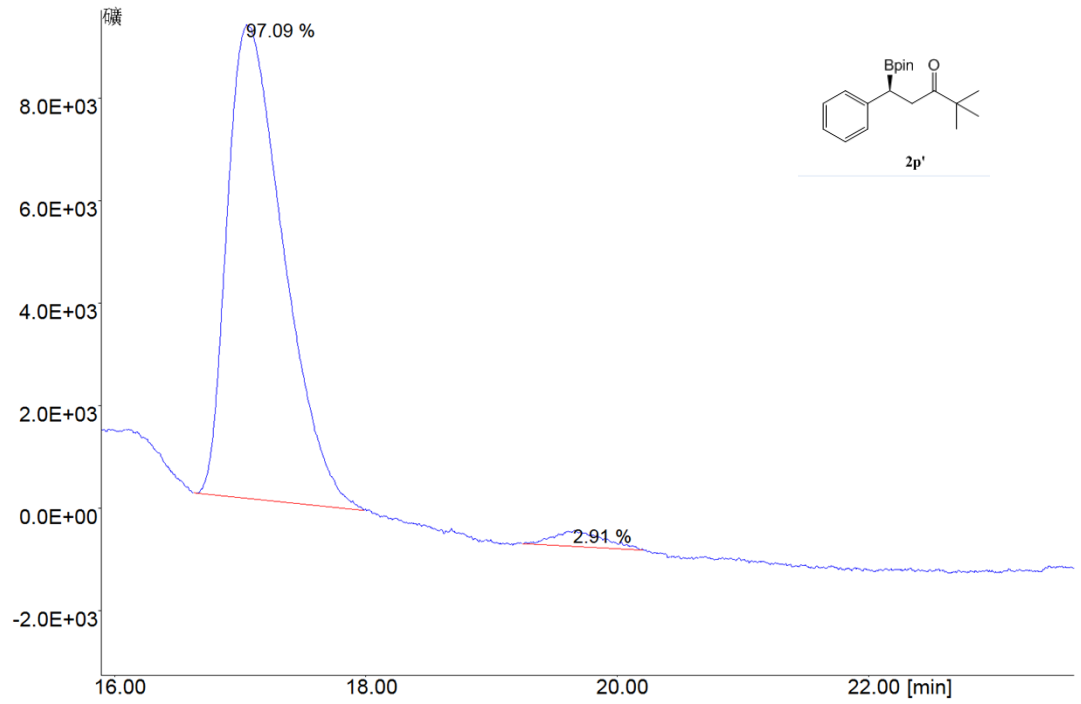
#	Name	RT	Height[礦]	Area[礦.Sec]	%Area
1		82.617	7495	526300.475	49.225
2		84.813	6096	542868.024	50.775



#	Name	RT	Height[礦]	Area[礦.Sec]	%Area
1		76.867	12776	863841.393	78.863
2		79.037	3537	231530.939	21.137



#	Name	RT	Height	Area[Sec]	%Area
1		16.957	5479	161188.094	49.152
2		19.243	4638	166749.800	50.848



#	Name	RT	Height	Area[Sec]	%Area
1		17.050	9239	285359.839	97.093
2		19.653	318	8544.725	2.907