Electronic Supplementary Material (ESI) for CrystEngComm.

Crystal structures and physicochemical properties of diltiazem base and its acetylsalicylate, nicotinate and L-malate salts

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Supporting Information

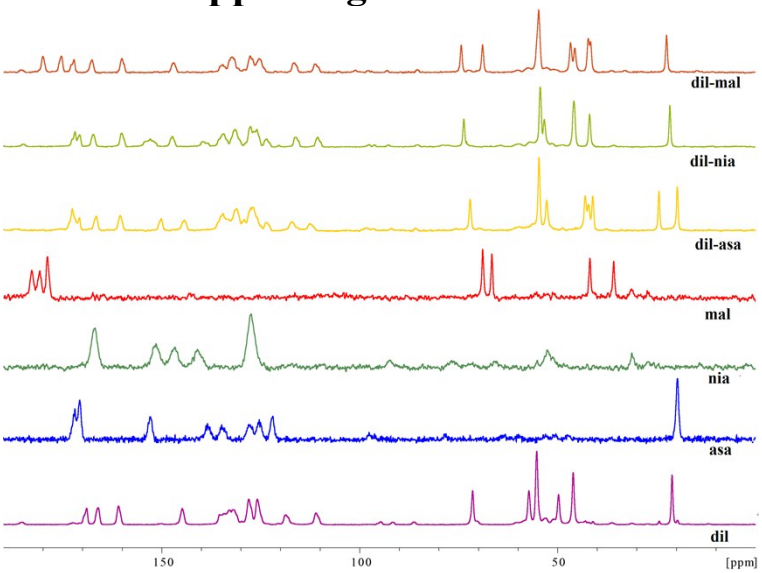


Fig. S1. Solid state ^{13}C CP-MAS

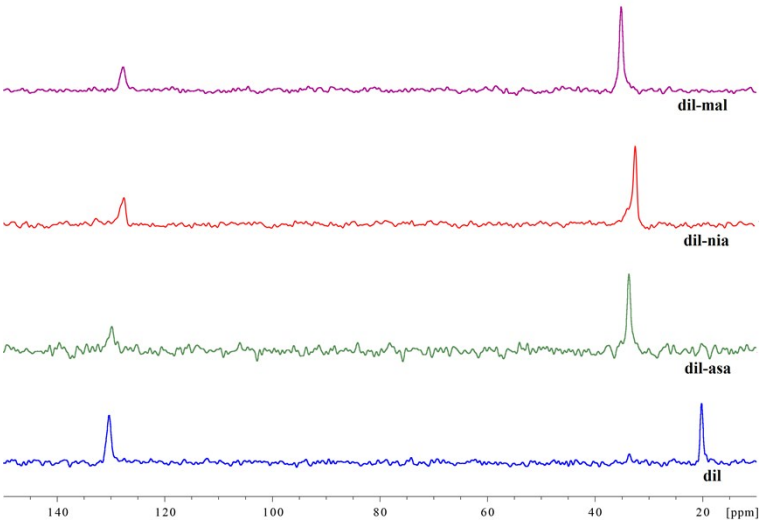
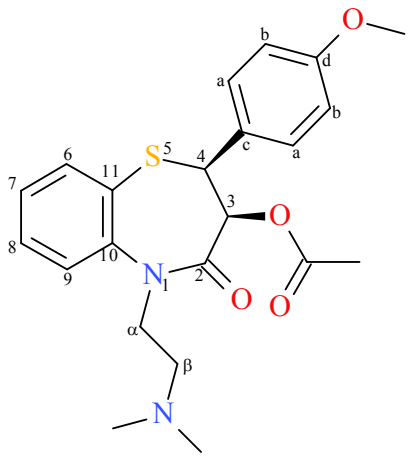


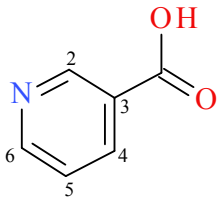
Fig. S2. Solid state ^{15}N CP-MAS

S3. NMR ^{1}H and ^{13}C chemical shifts for **dil** and its salts

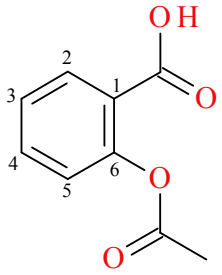
dil



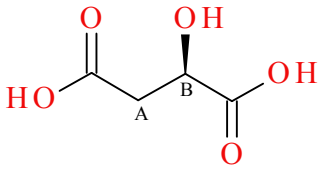
nia



asa



mal



^{1}H NMR chemical shifts

HSQC, **dil**-HCl	**dil**-HCl		**dil**	HSQC, **dil**	**dil-nia**	**dil-asa**	**dil-mal**
70.42	4.99	H-*3*	4.98	70.32	4.99	4.97	4.99
53.11	5.16	H-*4*	5.11	53.21	5.12	5.12	5.13
135.32	7.76 dd2	H-*6*	7.70	124.80	7.71	7.71	7.72
128.02	7.42 ddd2	H-*7*	7.34	127.35	7.49	7.35	7.37
131.57	7.65 ddd1	H-*8*	7.59	131.13	7.59	7.59	7.61
124.59	7.71 dd1	H-*9*	7.71	134.92	7.70	7.69	7.71
144.34	-	C-*10*	-	145.19	-	-	-
127.26	-	C-*11*	-	127.35	-	-	-
130.77	7.38	H-*a*	7.43	130.87	7.42	7.41	7.41
113.56	6.93	H-*b*	6.91	113.42	6.92	6.91	6.91
126.60	-	C-*c*	-	127.00	-	-	-
159.21	-	C-*d*	-	159.16	-	-	-
55.06	3.77	O-CH_3	3.77	55.03	3.77	3.76	3.77
43.69	4.17 4.44	H-*α*	3.71 4.26	46.81	3.81 4,3	3.76 4.28	3.85 4.31

52.45	3.12 3,45	H-*β*	2.28 2.51	56.50	2.42 2.69	2.39 2.64	2.59 2.86
20,21	1.83	$\underline{C}H_3$-C=O	1.82	20.24	1.82	1.82	1.82
169.24	-	CH_3-$\underline{C}$=O	-	169.14			
167.06	-	C-*2*	-	166.17			
42.11	2.79 br	N-CH_3	2.13	45.21	2.25	2.22	2.38

			nia		**dil-nia**		
		H-*2*	9.08		9.06		
		H-*4*	8.28		8.24		
		H-*5*	7.55		7.51		
		H-*6*	8.80		8.74		
		OH	13.40		…		

					asa	**dil-asa**	
			H-*2*		7.93	7.91	
			H-*3*		7.37	7.36	
			H-*4*		7.63	7061	
			H-*5*		7.19	7.17	
			CH_3C=O		2.24	2.23	
			OH		13.10	...	

						mal	**dil-mal**
					H-*A*	2.44 2.61	2.39 2.57
					H-*B*	4.25	4.12
					OH	12.40	...

^{13}C NMR chemical shifts

dil-HCl		**dil**	**dil-nia**	**dil-asa**	**dil-mal**
167.06	C2=O	166.17	166.33	165.76	166.54
70.42	C-*3*	70.32	70.35	70.34	70.36
52.45	C-*4*	53.21	53.21	53.20	55.14
135.32	C-*6*	134.92	135.00	134.99	135.10
127.63	C-*7*	127.63	127.58	127.59	127.53
126.60	C-*8*	127.00	126.94	126.95	126.85
124.59	C-*9*	124.80	124.75	124.77	124.72
144.34	C-*10*	145.19	145.06	145.08	144.87
128.02	C-*11*	127.35	127.48	127.47	127.64
43.69	C-*α*	46.81	46.29	46.39	45.73
53.11	C-*β*	56.50	55.78	55.96	53.19

130.77	C-*a*	130.87	130.87	130.87	130.85
113.56	C-*b*	113.42	113.45	113.45	113.47
131.57	C-*c*	131.13	131.20	131.20	131.30
159.21	C-*d*	159.16	159.18	159.17	159.19
169.24	O-C=O	169.14	169.17	166.31	169.19
55.06	O-CH_3	55.03	55.05	55.05	55.06
42.11	N-CH_3	45.21	44.64	44.79	44.19
20.21	CH_3-C=O	20.24	20.24	20.25	20.24

		nia	**dil-nia**		
	C-*2*	150.22	150.24		
	C-*3*	126.56	127.81		
	C-*4*	136.94	136.80		
	C-*5*	123.79	123.60		
	C-*6*	153.28	152.69		
	C=O	166.27	166.68		

			asa	**dil-asa**	
		C-*1*	124.04	123.69	
		C-*2*	123.77	124.48	
		C-*3*	126.05	125.98	
		C-*4*	131.37	131.35	
		C-*5*	133.77	133.54	
		C-*6*	150.17	150.12	
		CH_3-C=O	20.84	20.86	
		CH_3-C=O	169.17	169.17	
		HO-C=O	165.60	n/a	

				mal	**dil-mal**
			C-*A*	39.29	44.16
			C-*B*	67.03	66.62
			C-*A*-COOH	171.84	171.91
			C-*B*-COOH	174.62	175.37

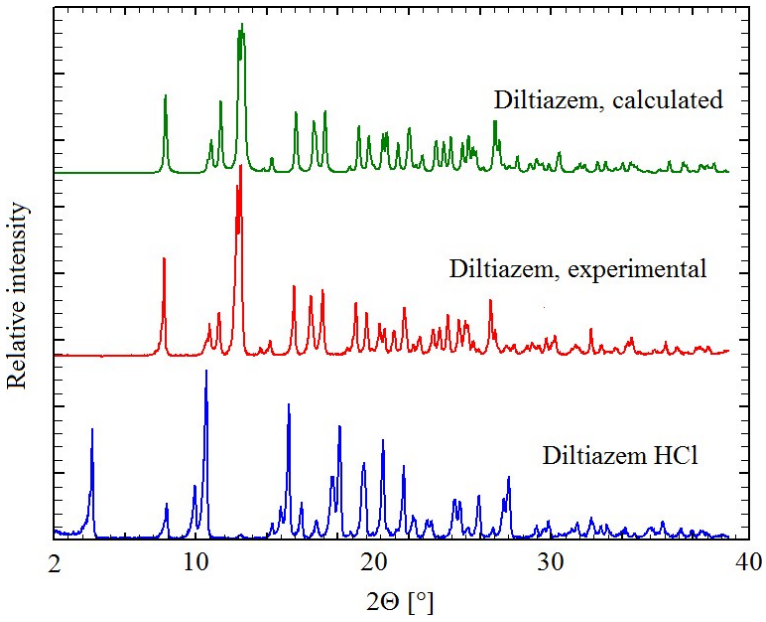


Fig. S4. Experimental PXRD pattern of diltiazem HCl (**dil**-HCl); experimental and calculated PXRD patterns of diltiazem base (**dil**)

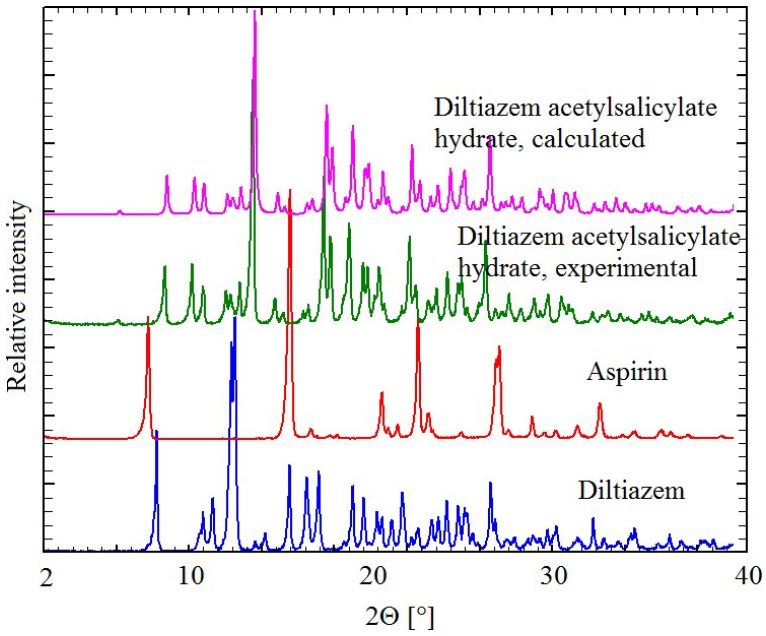


Fig. S5. Experimental PXRD patterns of diltiazem (**dil**) and aspirin (**asa**) in comparisson with experimental and calculated patterns of diltiazem acetylsalicylate hydrate (**dil-asa**)

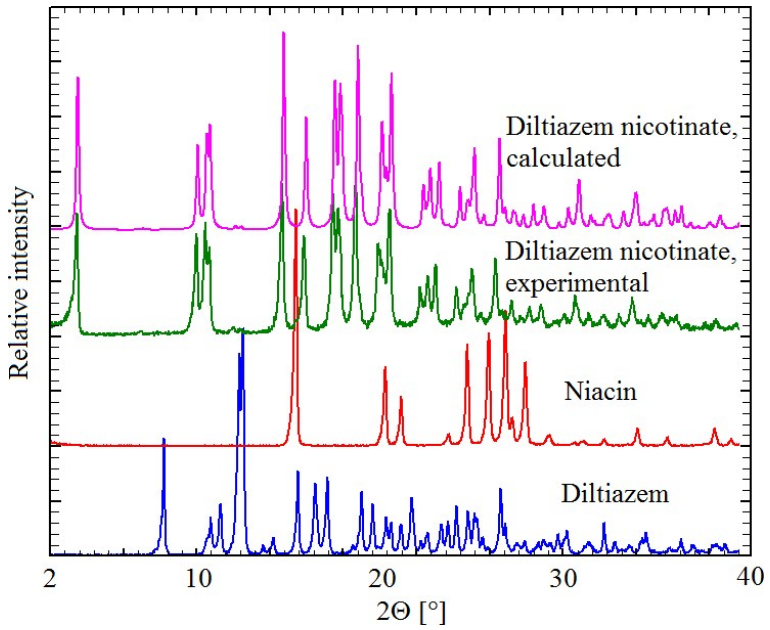


Fig. S6. Experimental PXRD patterns of diltiazem (**dil**) and Niacin (**nia**) in comparisson with experimental and calculated patterns of diltiazem nicotinate (**dil-nia**)

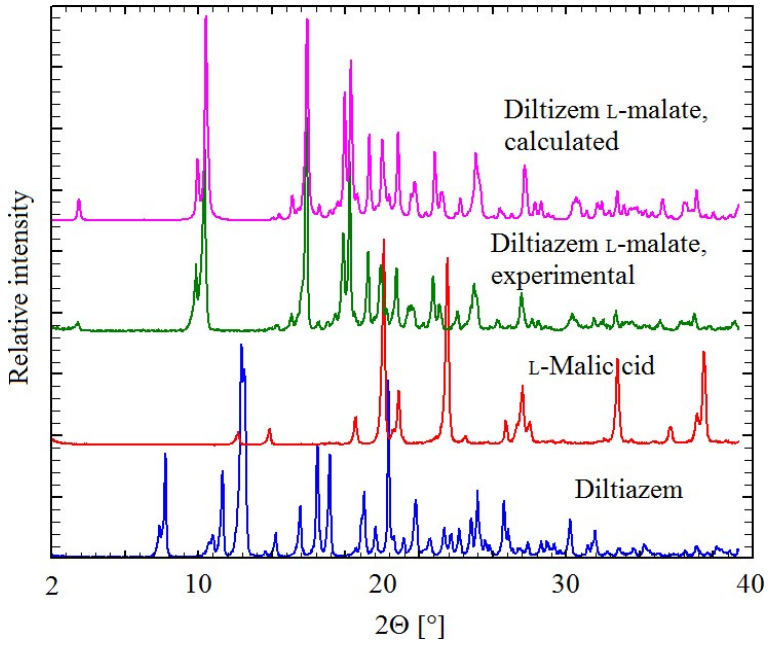


Fig. S7. Experimental PXRD patterns of diltiazem (**dil**) and L-malic (**mal**) in comparisson with experimental and calculated patterns of diltiazem L-malate (**dil-mal**)

Note: The calculated[1] and experimental X-ray diffraction patterns are equivalent (Figures S1–S4) (calculated[40] patterns are shifted a little to the right along *x* axis, because

experimental PXRD patterns were measured at room temperature, while single crystal X-ray measurements were carried out at low temperature of 173 (2) K).

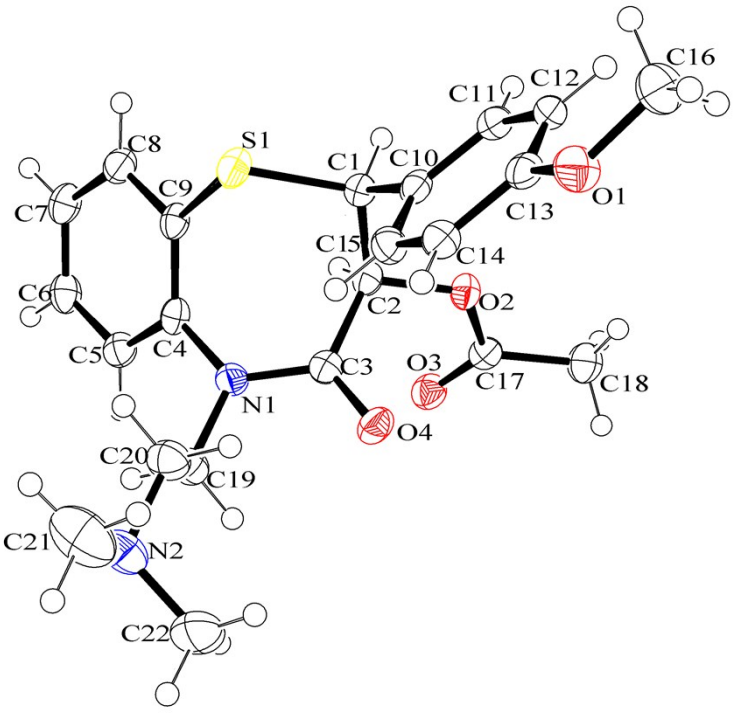


Fig. S8. ORTEP drawing of **dil**, showing the atom-numbering scheme

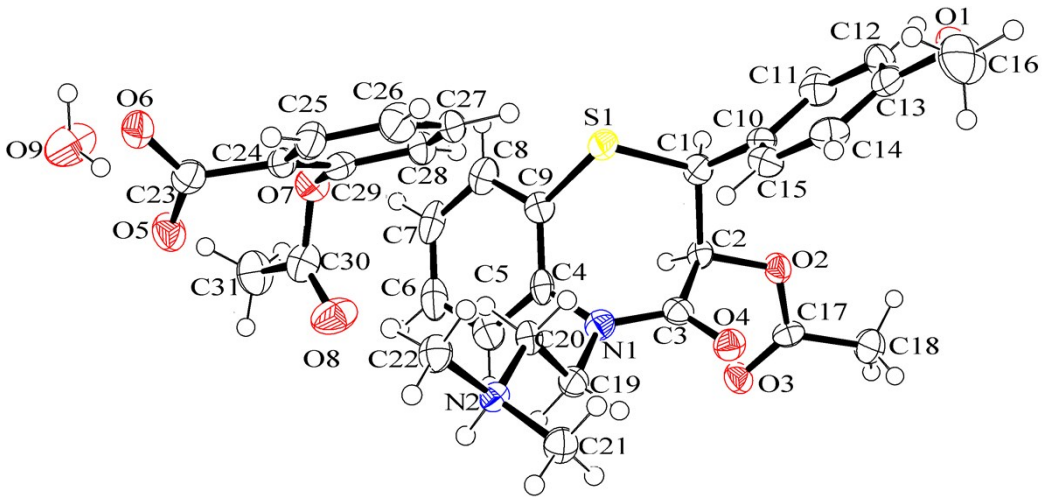


Fig. S9. ORTEP drawing of **dil-asa**, showing the atom-numbering scheme

[1] A calculated PXRD patterns were generated from the single crystal structures using Mercury CSD 31.1[40] and compared with the patterns collected from the bulk sample

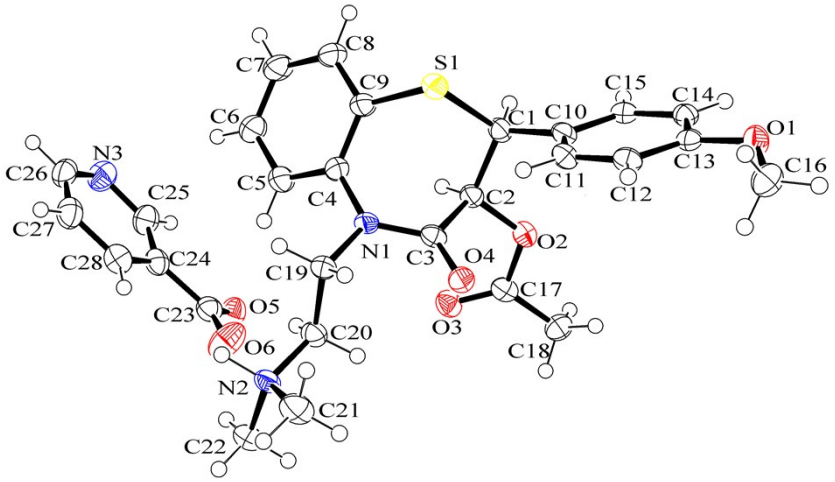


Fig. S10. ORTEP drawing of **dil-nia**, showing the atom-numbering scheme

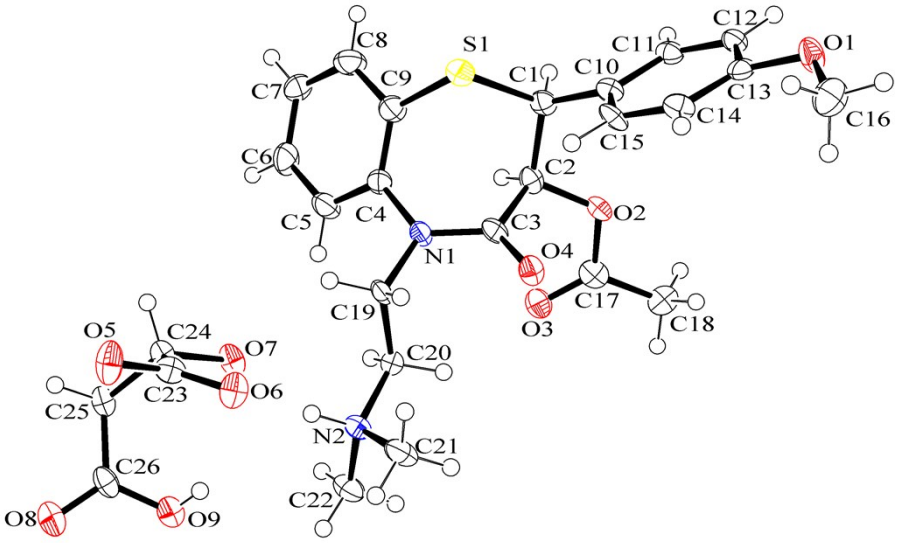


Fig. S11. ORTEP drawing of **dil-mal**, showing the atom-numbering scheme

Table S12. Torsion angles (τ) in the seven-membered ring

τ, ° / Compound	C2–S1–C1–C9	S1–C1–C2–C3	C1–C2–C3–N1	C2–C3–N1–C4	C3–N1–C4–C9	N1–C4–C9–S1	C4–C9–S1–C1
dil	-27.8(2)	-55.6(2)	83.6(2)	1.4(3)	-49.8(4)	-7.8(3)	66.8(2)
dil-asa	-32.8(3)	-51.5(4)	84.3(5)	-0.8(6)	-51.8(6)	-5.4(6)	68.5(4)
dil-nia	-39.9(2)	-45.0(3)	89.9(3)	-10.1(3)	-48.7(3)	-1.7(3)	70.4(2)
dil-mal	-41.0(4)	-42.9(5)	90.7(5)	-13.7(7)	-46.0(7)	-1.9(7)	70.8(4)

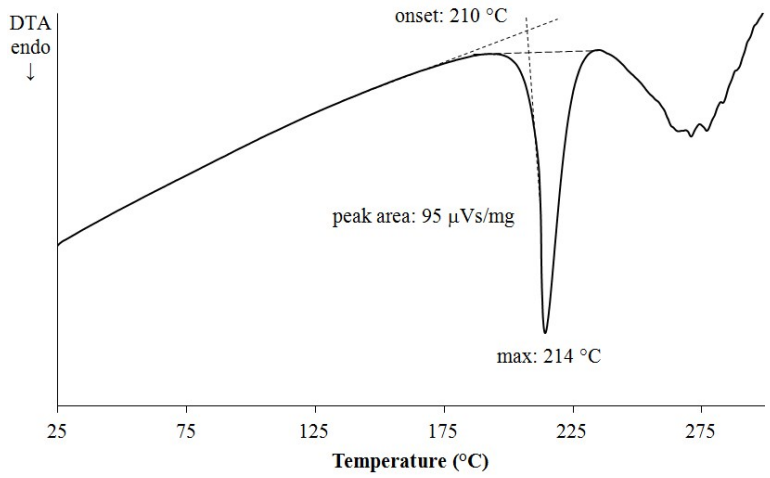


Fig. S13. DTA curve showing thermal properties of **dil**-HCl

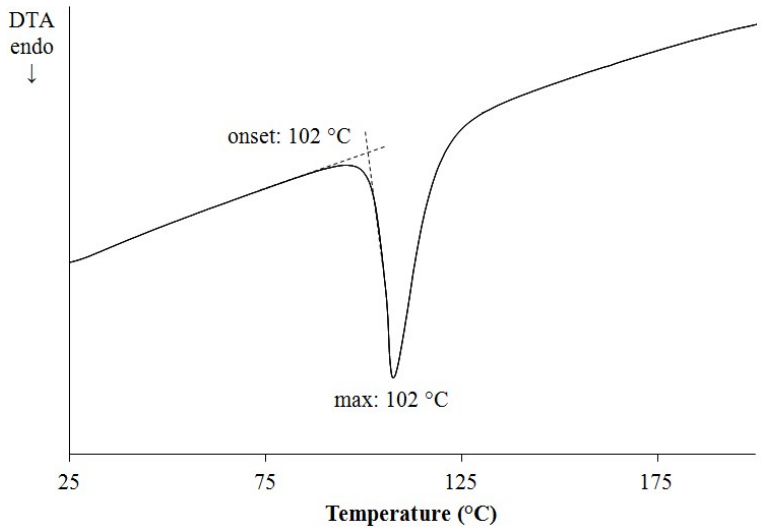


Fig. S14. DTA curve showing thermal properties of **dil**

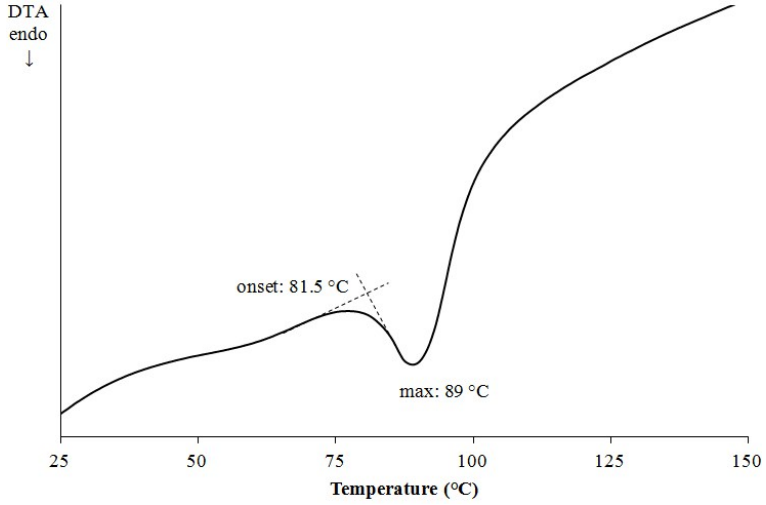


Fig. S15. DTA curve showing thermal properties of **dil-asa**

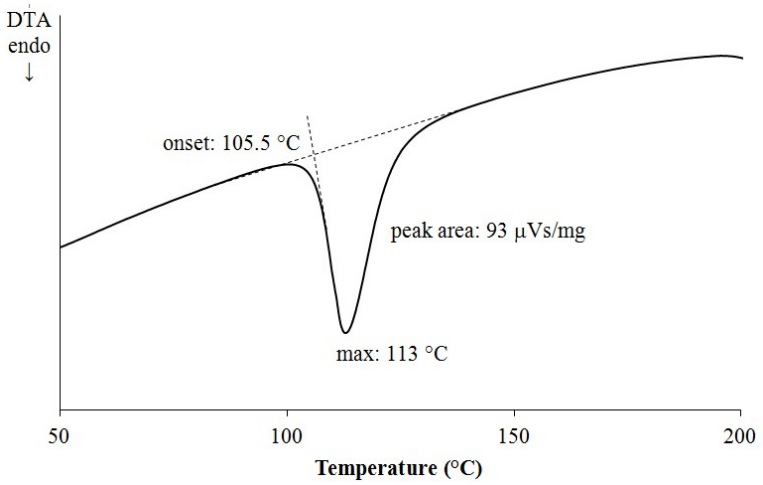


Fig. S16. DTA curve showing thermal properties of **dil-nia**

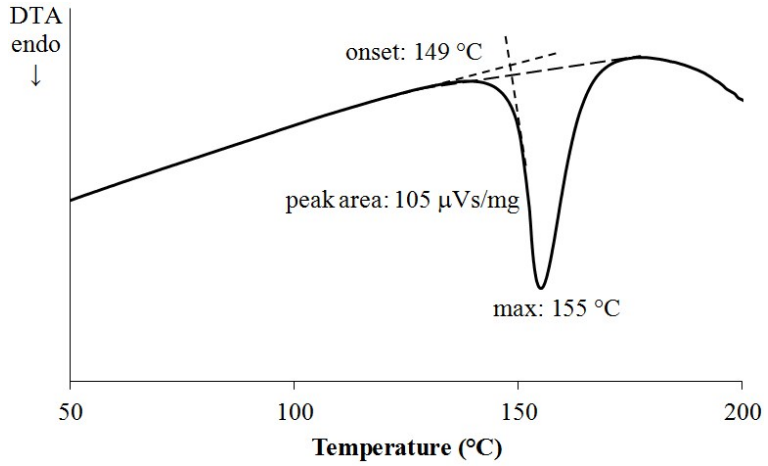


Fig. S17. DTA curve showing thermal properties of **dil-mal**

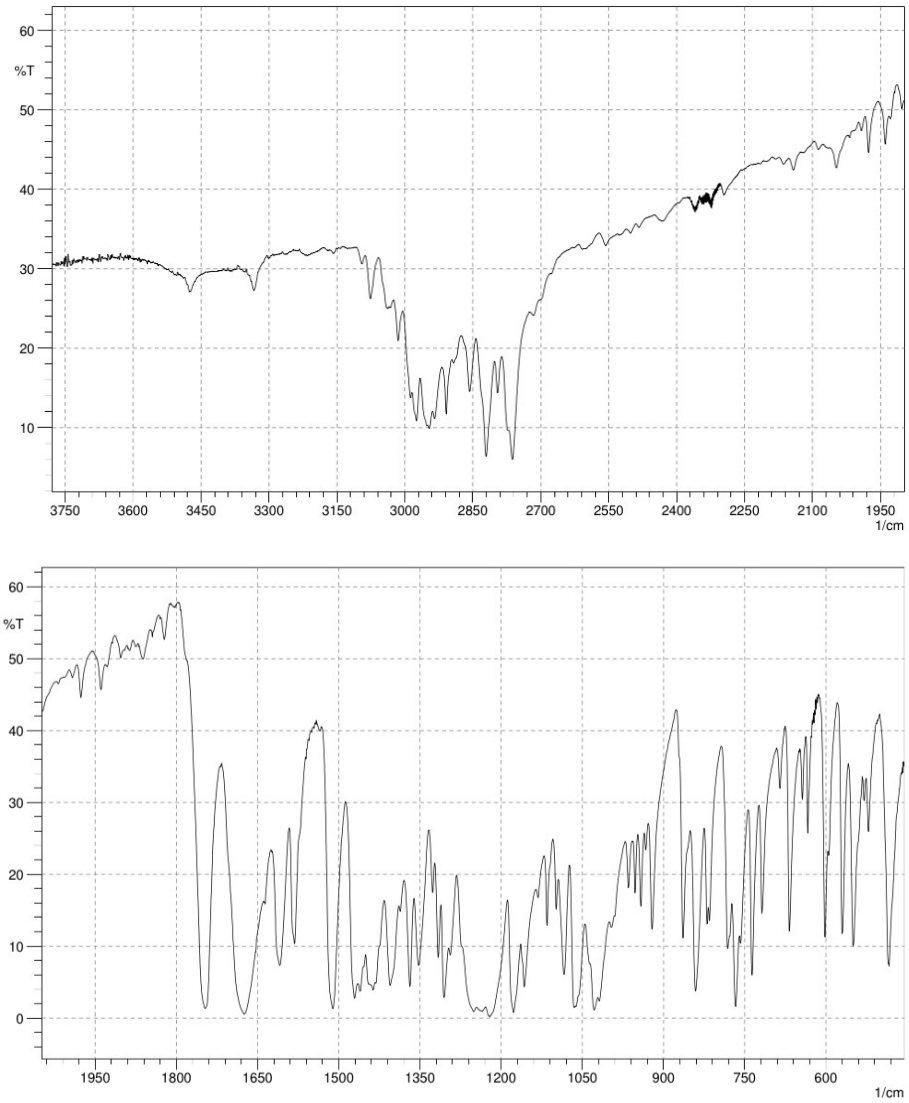


Fig. S18. FT-IR of **dil**

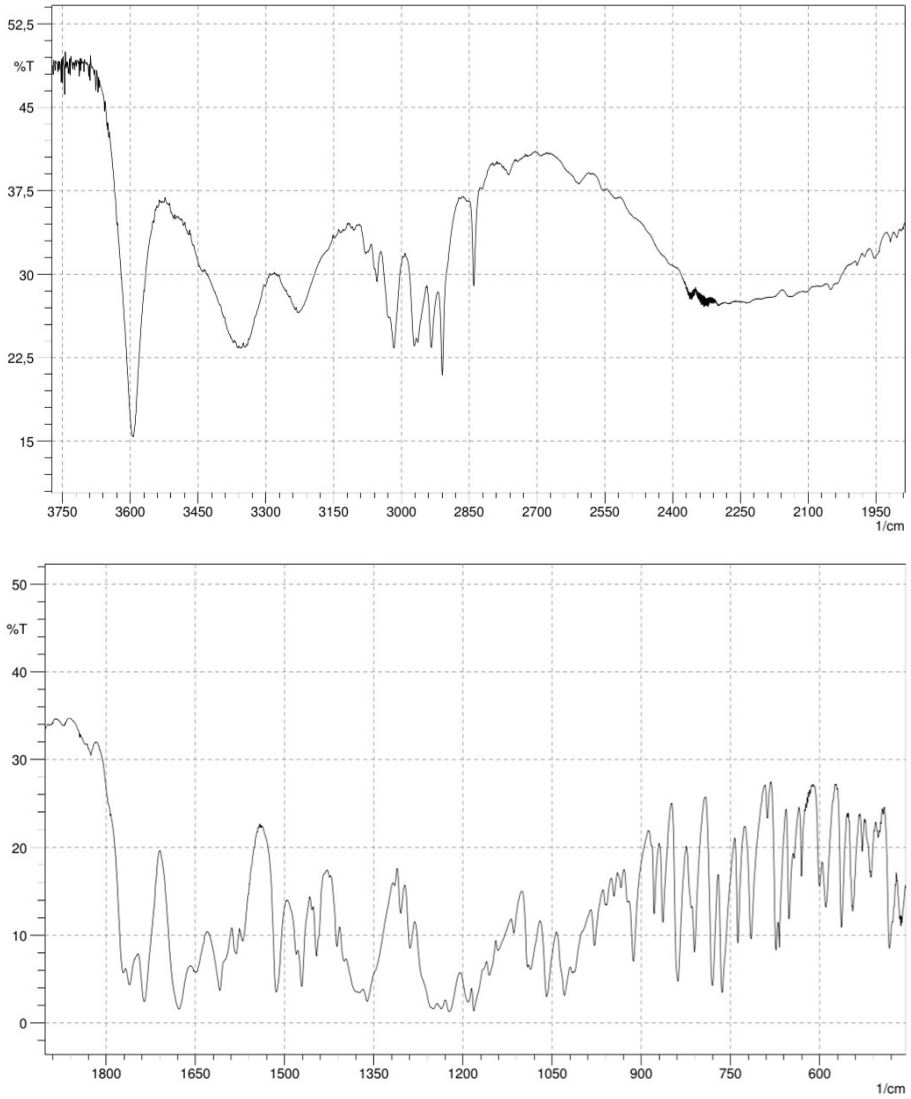


Fig. S19. FT-IR of **dil-asa**

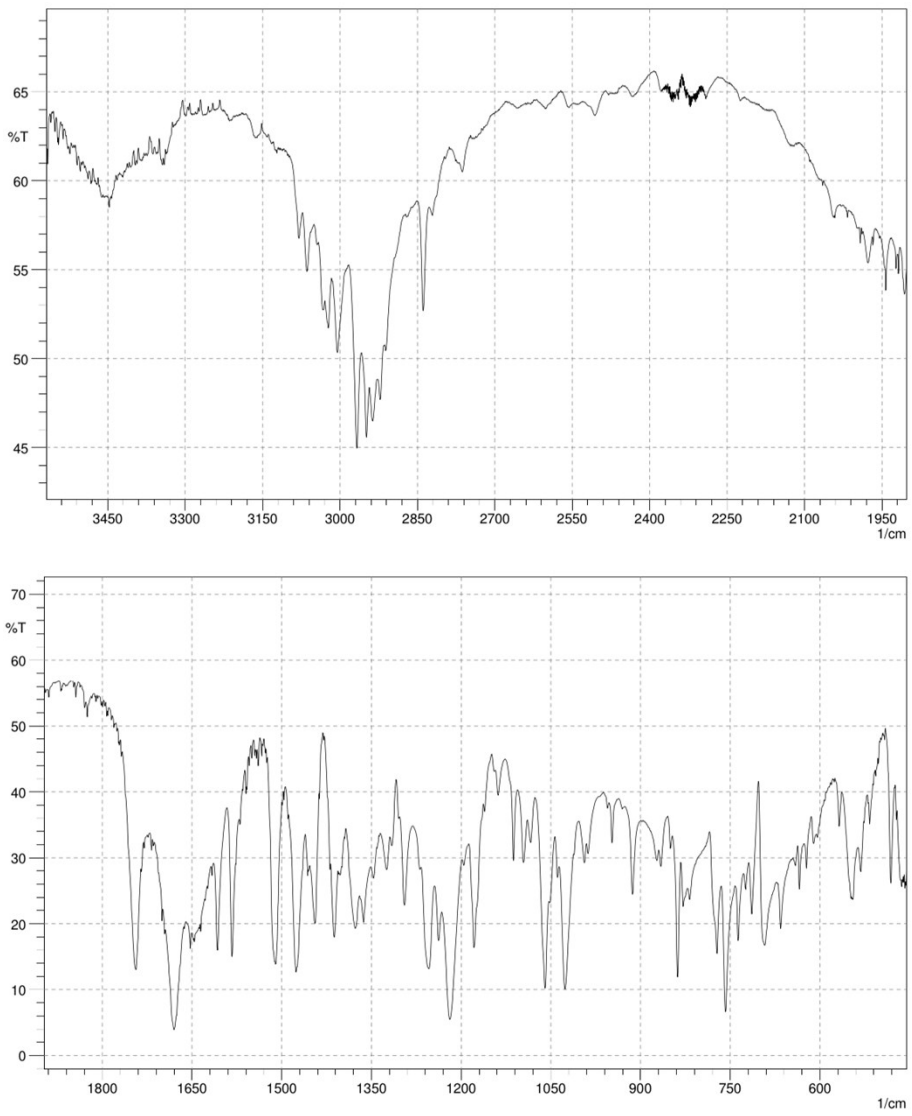


Fig. S20. FT-IR of **dil-nia**

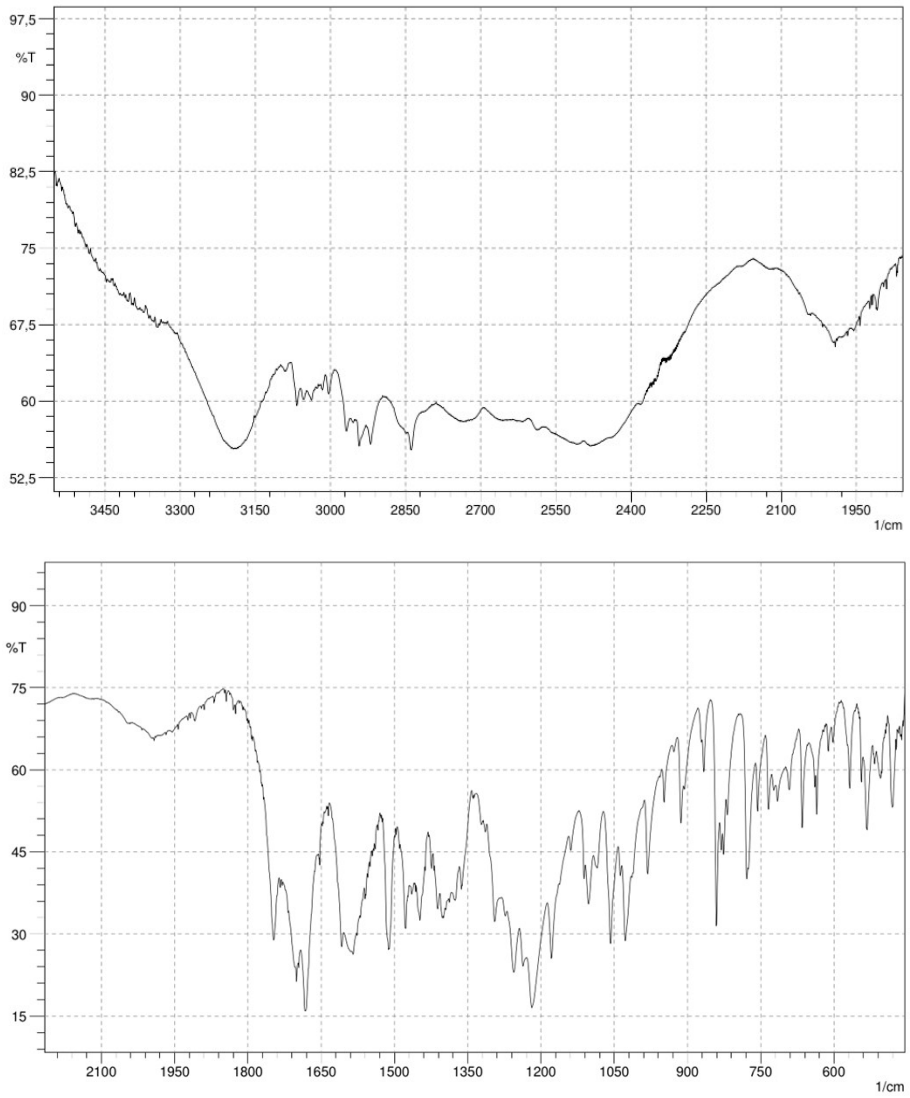


Fig. S21. FT-IR of **dil-mal**