

Supplementary Information

In depth-study of binary ethanol-triacetin mixtures in
relation with their excellent solubilization power

Hofmann *et al.*

S.1 Gaussian calculations

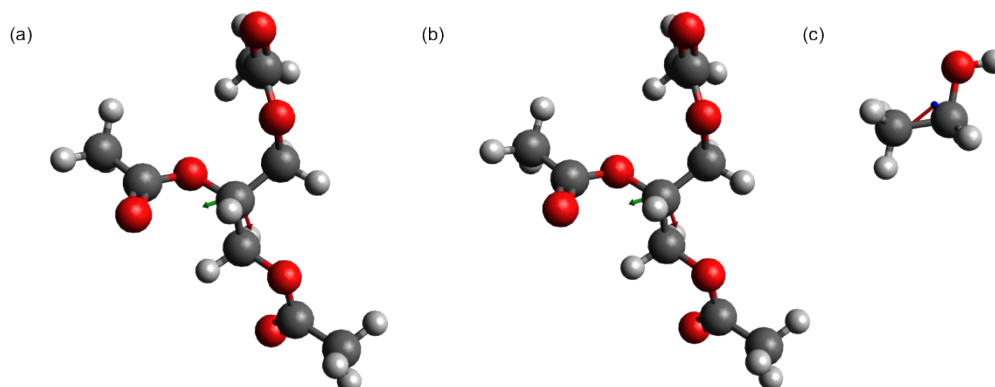


Figure S - 1: Optimized geometry of (a) TriA in EtOH, (b) TriA in a continuum with a dielectric constant of 6.8, and (c) EtOH in EtOH using Gaussian software. The Avogadro software¹ (Version 1.1.1) is used for visualization of the molecules.

Table S - 1: Theoretically determined dipole moment μ of TriA and EtOH in different solvents, whereby the solvent “TriA” is represented by a continuum with a dielectric constant of 6.8. Calculations were performed by means of the Gaussian program.

molecule	TriA		EtOH
solvent	EtOH	“TriA”	EtOH
μ [D]	5.3	5.5	2.2

S.2 Density and viscosity measurements

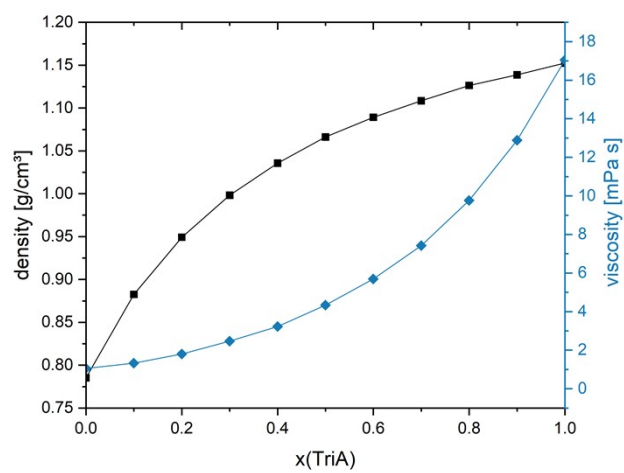


Figure S - 2: Experimentally determined densities and viscosities of binary EtOH/TriA mixtures at 25 °C as a function of the amount of TriA.

S.3 COSMOtherm calculations

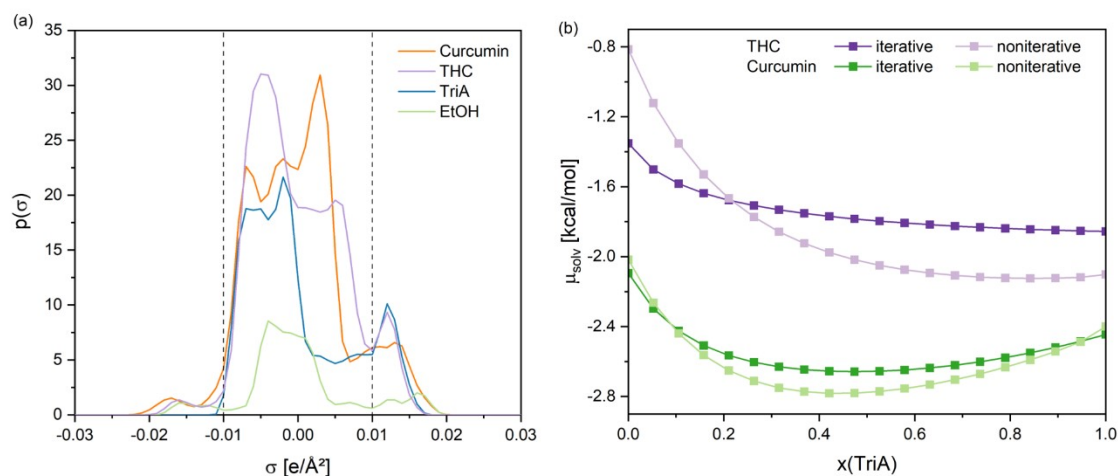


Figure S - 3: (a) Predicted σ -profiles of curcumin (orange curve), THC (purple curve), TriA (blue curve), and EtOH (green curve). The contributions of the individual conformers are weighted by their weight factor given in the corresponding pure compounds. (b) Comparison of iteratively and non-iteratively predicted chemical potential of the solutes THC and curcumin in different EtOH/TriA mixtures as a function of the amount of TriA.

Degot *et al.* revealed a correlation between the predicted chemical potential at infinite dilution (non-iterative calculations) and the experimentally determined solubilities.² In the published work², the σ -profiles were taken into account to interpret the results (see Fig. S – 3(a)). TriA (blue curve) has a rather non-polar surface (σ around $0 \text{ e}/\text{\AA}^2$) with some highly polar surface segments with hydrogen bond acceptor abilities ($\sigma > 0.01 \text{ e}/\text{\AA}^2$, oxygen atoms). Due to the lack of potential hydrogen bond donor segments with sufficient negative σ , an electrostatic misfit is present in pure TriA. By the addition of EtOH (green curve), which possesses both potential hydrogen bond donor ($\sigma < 0.01 \text{ e}/\text{\AA}^2$) and acceptor segments ($\sigma > 0.01 \text{ e}/\text{\AA}^2$), the misfit can be reduced. Curcumin (orange curve) has mainly non-polar surface segments. In addition, the molecule also exhibits hydrogen bond donor and acceptor abilities. In mixtures of EtOH and TriA, the curcumin can thus interact via Van-der-Waals interactions, especially with the non-polar TriA, and can form hydrogen bonds with both solvent molecules. The EtOH was expected to reduce the overall electrostatic misfit of the solution due to lacking hydrogen bond donor segments on both molecular surfaces, curcumin and TriA. Accordingly, it was assumed that the

synergistic solubilization arises due to an optimum interplay of Van-der-Waals, electrostatic, and hydrogen bonding interactions. In addition, the small molecule size of EtOH may allow faster penetration between the curcumin molecules.² Since predictions fail in the case of tetrahydrocurcumin, we tried to optimize the predictions by using iterative calculations. However, no improvement was observed (see Fig. S – 3(b)). Furthermore, it is noticeable that the σ -profile of THC (Fig. S – 3(a), purple curve) is very similar to that of TriA. This could explain the predicted minimum in the chemical potential of THC in pure TriA.

S.4 Scattering experiments

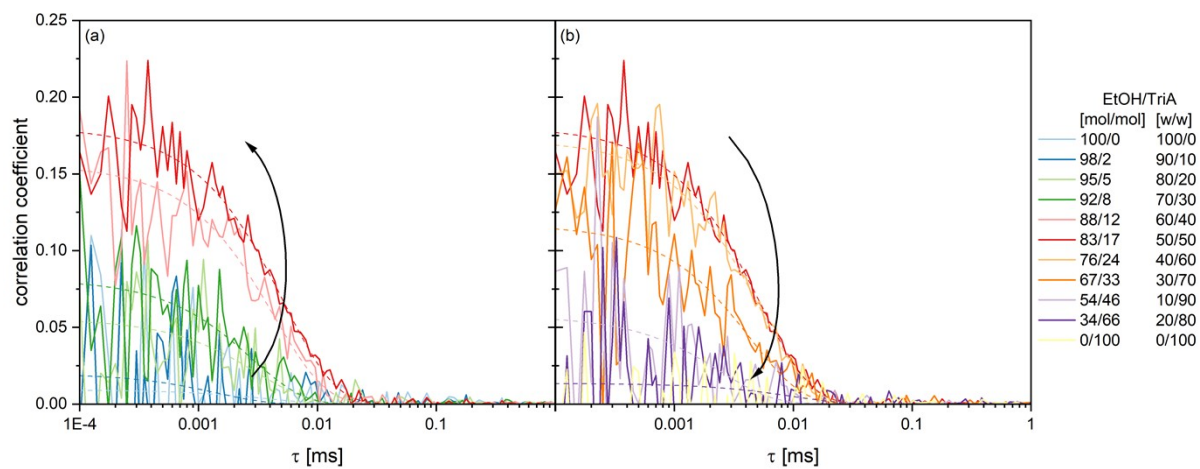


Figure S - 4: Correlation functions of binary EtOH/TriA mixtures obtained by DLS measurements at 25 °C with their exponential fits (dashed line).

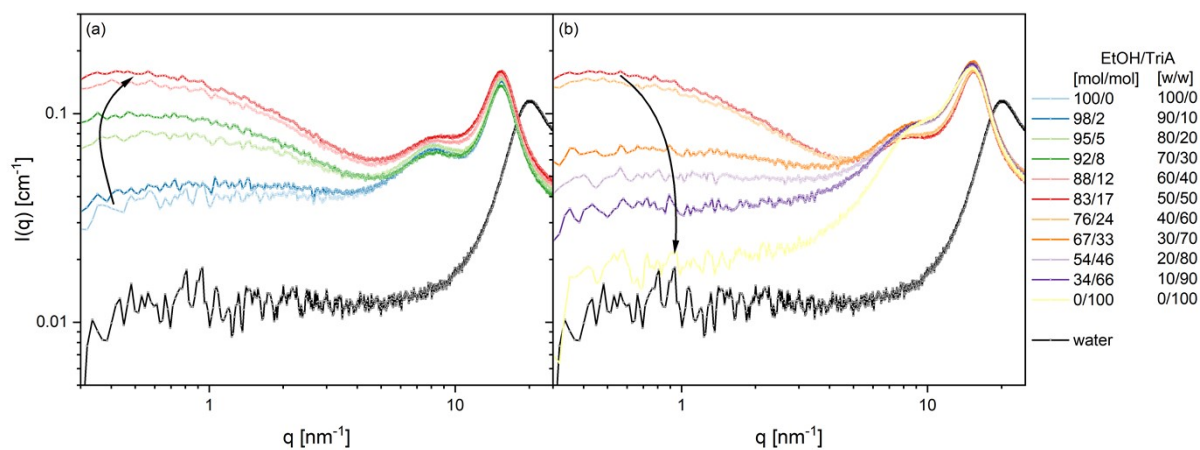


Figure S - 5: Experimentally determined SWAXS spectra of binary mixtures EtOH/TriA.

S.5 DRS measurements

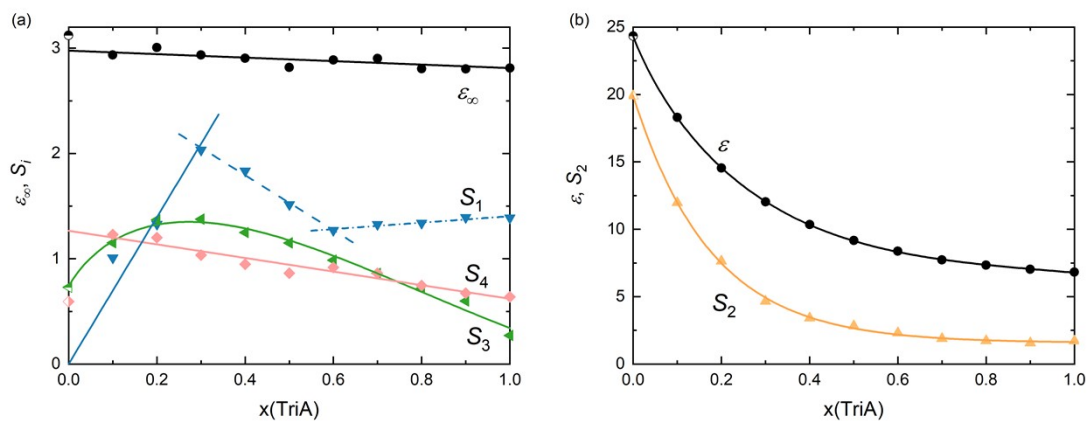


Figure S - 6: The amplitudes S_i , the infinite-frequency limit ϵ_{∞} , and the dielectric constant ϵ in mixtures of EtOH and TriA as a function of the TriA fraction $x(\text{TriA})$.

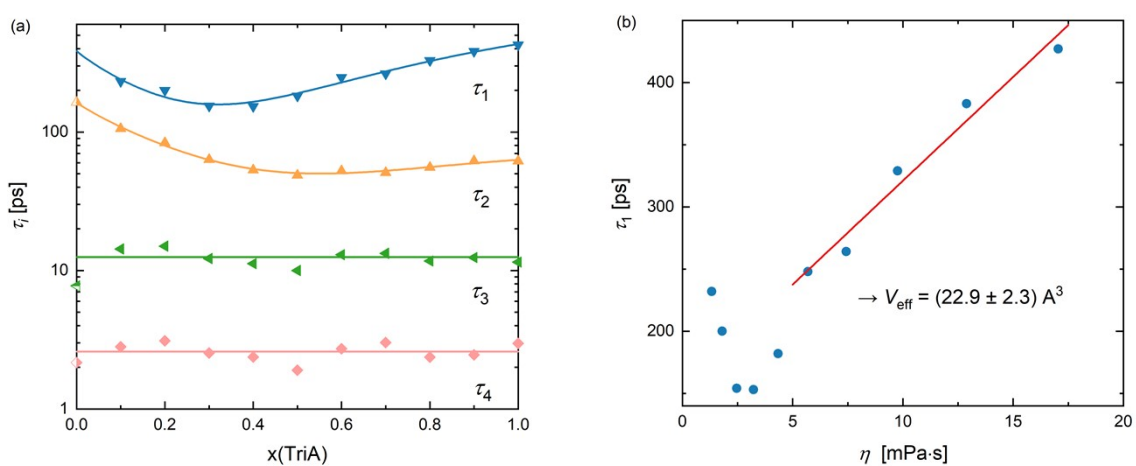


Figure S - 7: (a) Relaxation times, τ_i ($i=1-4$), of TriA/EtOH mixtures at 25 °C. (b) Stokes-Einstein-Debye plot (relaxation time τ_1 as a function of viscosity, η) for the TriA associated mode D_1 .

Table S - 2: Dielectric constant ϵ , infinite-frequency permittivity ϵ_∞ , relaxation amplitudes S_i , and relaxation times τ_i [ps] of the sum of four Debye equations fitted to the DR spectra of binary EtOH/TriA mixtures with varying TriA fraction $x(\text{TriA})$ at 25 °C.

$x(\text{TriA})$	ϵ	ϵ_∞	S_1	τ_1	S_2	τ_2	S_3	τ_3	S_4	τ_4
0.1	18.303	2.936	1.009	232	11.978	106	1.151	14.3	1.229	2.81
0.2	14.542	3.006	1.327	200	7.639	83.5	1.37	15.0	1.200	3.11
0.3	12.031	2.936	2.033	154	4.652	63.2	1.376	12.2	1.034	2.54
0.4	10.346	2.904	1.833	153	3.412	53.2	1.249	11.2	0.947	2.37
0.5	9.167	2.818	1.515	182	2.822	48.8	1.150	10.0	0.862	1.91
0.6	8.370	2.887	1.269	248	2.310	52.5	0.987	13.0	0.917	2.72
0.7	7.724	2.903	1.326	264	1.891	50.9	0.861	13.3	0.861	3.02
0.8	7.335	2.804	1.338	329	1.729	55.6	0.717	11.7	0.746	2.37
0.9	7.031	2.803	1.392	383	1.564	61.9	0.599	12.4	0.673	2.46
1	6.816	2.81	1.389	427	1.707	61.8	0.272	11.5	0.637	2.98

