

Small molecules to control phase transitions in lipid-based systems

Content

Lipid-based formulations are found in many fields of applications, including food, and drug delivery. In lipid-based formulations, one takes advantage that different self-assembled structures can possess widely different properties in terms of both solubilization and release of active compounds. Different phases may also have different spreading properties when the formulation comes into contact with a surface, and they may have widely different water-holding capacity.

The focus here is on how one can tune dehydration-induced transitions in the lipid self-assembly by the addition of small molecules that can be either hydrophilic, hydrophobic or of intermediate polarity. Examples obtained for simple model mixtures will be shown together with example of lipids in a complex biomaterial, that is the stratum corneum (SC, upper layer of human skin). Even though these are not examples of food, the principles discussed are general and should be applicable also to applications in food.

Typically, the addition of a small hydrophobic compound will alter the balance between fluid and solid lipid structures, analogous to melting point depression. This effect of adding a hydrophobic compound is relevant at both high and low water contents (1).

If one instead adds hydrophilic compounds, often referred to as osmolytes, the effect on lipid phase behavior will depend on the water content. When the humidity is decreased, water will evaporate, while the hydrophilic compounds with low vapor pressure will remain in the lipid system where it can basically replace water and maintain properties as the hydrated sample both in terms of lipid and protein fluidity (2).

Finally, compounds with intermediate polarity are expected to dissolve in both water-rich and oily regions of the lipid system, and their distribution will depend on the water content of the sample. We have studied the distribution and the influence on lipid self-assembly of model compound 1,2,3-trimethoxy propane (TMP, log Po/w of -0.1) in the SC at varying water contents (3). It is shown that the intermediate polarity additive has a dual behavior when added to a lipid-based system, changing from behaving like a hydrophobic additive at low water contents, to behaving like a hydrophilic additive at high water contents. As a consequence, the water content can be used as a "switch" to control the distribution and thus the molecular effects of the added chemical.

References

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Comments:

I will be in a thesis defence on Friday June 3 and cannot present this day

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