Water, the main alternative solvent for green extraction of natural products

Water is the most abundant molecule on Earth, covering 70% of the surface. Life processes on this planet are crucially dependent on the presence of water. It is often recognized that the use of water as a solvent has tremendous benefits as a green extraction solvent because water is not only inexpensive and environmentally benign; but it is also non-flammable, nontoxic, providing opportunities for clean processing and pollution prevention.

At a critical concentration, it is unavoidable that the large hydrophobic hydration shells start to overlap, leading to mutually destructive breakdown of these water arrangements. This H-bonding interactions results in a solvent-induced sticking together of hydrophobic surface areas of the two solutes, primarily driven by the gain in entropy that comes from the release of water molecules from the hydrophobic hydration shells into bulk water. Hydrophobic hydration shells are quite voluminous. Depending on the nature of the hydrophobic molecules, one can distinguish pairwise interactions, the formation of small aggregates ('moving units', for example in the case of hydrotropes) and the formation of larger aggregates (bulk hydrophobic interactions) as in the case of surfactant aggregates like micelles and vesicles. The ultimate state of aggregation will, of course, involve phase separation.

Using water as alternative solvent for synthesis, purification or extraction is a research area that has an impact in several fields of modern chemistry. The advantages of using water as alternative solvent for extraction includes: reduced environmental impact, selective extraction, use of simple equipment, no hazards, faster start-up, and simplification of process steps.

We will present a complete picture of current knowledge on using water as alternative solvent for natural product extraction. It provides the necessary theoretical background and some details about extraction using water, the technique, the mechanism, some applications, and environmental impacts.