Solvent-free functional biofluids as a route for retained structure and improved protein stability in nonaqueous environments

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Enzymes can perform many industrially relevant reactions, and under significantly milder conditions than their chemical counterparts. As a result, research into the use of enzymes as industrial biocatalysts has been gaining ground, particularly in conjunction with emerging solvent systems such as ionic liquids. However, enzymes often have very low solubilities in nonaqueous environments and are frequently unstable, limiting the window of usability. Consequently, there is an impetus to develop new biotechnology to improve solubility and stability of biocatalysts in nonaqueous media.

Solvent-free functional biofluids have been demonstrated as a promising new technology where enzymes have been stabilized in non-aqueous environments. Using a variety of spectroscopic and scattering techniques, these novel biomaterials have been shown to allow for extreme enzyme thermal stability[1], stability against aggregation[2], and retained dynamics[3] and function[4]. Recently, biofluids of the industrially important enzyme lipase have been created. Remarkably, the enzyme activity was not only retained in the absence of water, but actually enhanced at temperatures up to and including 150 °C[5].

Our recent results show that these novel biofluids are soluble in both hydrophilic and hydrophobic ionic liquids, and we demonstrate that biomolecule architecture can be preserved in the non-aqueous environment. Furthermore, the solubilized protein displays improved thermal stability as compared to aqueous solutions. As a result, this nascent technology could provide a platform for biocatalysis in industrially relevant nonaqueous solvent systems.

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