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In search of the perfect environment: The quest to maximize macromolecule stability

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PURPOSE OF THE ABSTRACT

Current literature unquestionably implies that deep eutectic solvents (DES)- mediated biocatalytic approach is an exciting new field with enormous possibilities for improving reaction efficiency and sustainability through better substrate solubility/loading, improved enzyme activity and stability. [1] Except for enzymes, other macromolecules used in biocatalysis, such as cofactors, struggle with long-term stabilization in liquid form. Due to their complex structure, macromolecules can be unstable and prone to denaturation, especially in harsh environments like extreme temperatures or pH conditions. Therefore, their stabilization is critical in many scientific fields, including biotechnology, pharmaceuticals, and medical research. This study aims to show that DES can be effective in stabilizing enzymes and other macromolecules by providing a suitable environment for their function and stability. DES can help to maintain their structure and reduce denaturation in harsh conditions. Moreover, in some cases, DES can also enhance the activity and selectivity of enzymes. [2]

Implementation of green chemistry principles through the use of DES represents an up-to-date solution fighting waste generation. These non-toxic and non-flammable solvents are mixtures of cheap, natural and readily available components prepared by mixing hydrogen bond acceptors (HBA) such as quaternary ammonium salts and hydrogen bond donors (HBD) based on natural products, in a specific molar ratio resulting homogenous solution based on hydrogen bonds between DES components. One of the major attractions of making DES an alternative to organic solvents lies in the tremendous number of structural combinations, thus it is possible to rationally design an optimal one for each specific application. [3] The vast number of possible chemical structures, in addition to unique physical and chemical properties, and low environmental impact make DES interesting for industrial use. [4]

Therefore, a new window of opportunities for DES application is presented in the stabilization of macromolecules. Stabilization of macromolecules refers to the methods that prevent or minimize the breakdown of these molecules, thereby maintaining their structure and function. So far, techniques for stabilizing macromolecules include chemical modifications (use of cross-linkers or protease inhibitors), physical methods (freeze-drying or lyophilization), use of chaperones or pH adjustment. Finding the right environment for an optimal desired state of a macromolecule with minimized degradation can be quite challenging. Therefore, due to their natural origin, DES can mimic the macromolecule's natural environment more effectively. To sum up, this study presents the use of betaine and choline chloride-based DES as a medium for several alcohol dehydrogenases and nicotinamide cofactors long-term stabilization.

In the end, we can conclude that macromolecule stabilization is a promising area of research with potential applications in various fields, including biotechnology and pharmaceuticals.

FIGURES

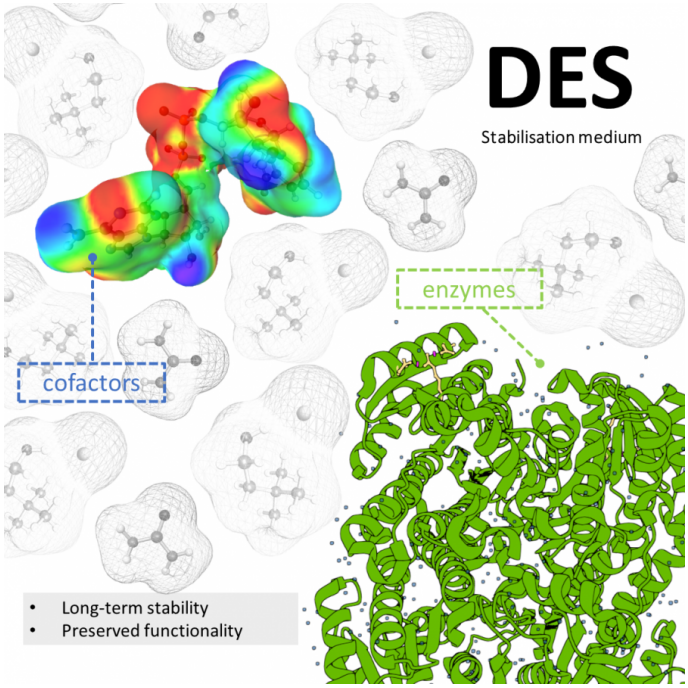

FIGURE 1

Graphical summary of the research
DES (deep eutectic solvents)

FIGURE 2

KEYWORDS

macromolecules | deep eutectic solvents | stabilization

BIBLIOGRAPHY