

Improving Enzyme Durability and Integration Capabilities by Immobilization

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DESCRIPTION

Enzyme immobilization is a technique that involves attaching or confining enzymes to a solid support, enabling their reuse, stability, and application in various industrial, medical, and environmental processes. This process enhances the operational and storage stability of enzymes, expands their substrate range, and facilitates the development of robust biocatalysts.

Methods of enzyme immobilization

Enzyme immobilization employs diverse methods to anchor enzymes onto solid supports:

Adsorption: Enzymes are physically adsorbed onto solid materials through hydrophobic interactions, electrostatic forces, or affinity interactions. Common supports include activated carbon, silica, and various polymers.

Covalent binding: Enzymes are covalently linked to the support through chemical reactions. This method provides strong enzyme attachment and stability, but careful optimization is required to preserve enzyme activity.

Encapsulation: Enzymes are encapsulated within a matrix or microcapsule, protecting them from harsh environments and allowing controlled release. Materials such as alginate, agarose, and synthetic polymers are commonly used for encapsulation.

Cross-linking: Enzymes are cross-linked using chemical agents or physical methods, forming a stable network. This method immobilizes enzymes within a three-dimensional structure, enhancing stability and preventing leaching.

Advantages of enzyme immobilization

Compared to free enzymes, immobilized enzymes have the following benefits:

Enhanced stability: Immobilized enzymes exhibit improved stability against temperature, pH fluctuations, and harsh reaction conditions, making them more robust and suitable for industrial applications.

Reusability: Immobilized enzymes can be reused multiple times, reducing the cost and effort associated with enzyme production and purification.

Increased substrate range: Immobilization expands the substrate range of enzymes, allowing them to catalyze reactions that would be difficult for free enzymes. It enables the use of enzymes in non-aqueous solvents, high-temperature environments, and other challenging conditions.

Operational efficiency: Immobilized enzymes can be easily separated from the reaction mixture, simplifying downstream processes and facilitating product purification.

Protection from proteolysis: Immobilization protects enzymes from proteolytic degradation, prolonging their lifespan and enabling their application in biological environments.

Applications of enzyme immobilization

Enzyme immobilization finds applications in various fields:

Bio catalysis: Immobilized enzymes are widely used in industrial biocatalysis for the production of pharmaceuticals, fine chemicals, and biofuels. They offer higher reaction rates, improved productivity, and simplified downstream processing.

Biomedical and diagnostic applications: Immobilized enzymes are utilized in biosensors, diagnostic kits, and drug delivery systems. They enable rapid and sensitive detection of analytes and controlled release of therapeutic agents.

Food and beverage industry: Immobilized enzymes play a crucial role in food processing, such as the production of juices, dairy products, and brewing. They enhance process efficiency, improve product quality, and enable continuous production.

Environmental remediation: Immobilized enzymes contribute to environmental sustainability by facilitating the degradation of pollutants and the treatment of wastewater.

CONCLUSION

Enzyme immobilization is a powerful technique that enhances

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the stability, reusability, and versatility of enzymes, expanding their applications across various industries. This process provides opportunities for the development of robust biocatalysts, making enzyme-based processes more efficient, sustainable, and economically viable. Immobilised enzymes used in the food, chemical, pharmaceutical, and healthcare industries. For instance, immobilised enzymes are employed in

the food business to create a variety of zero-calorie sweeteners. Allulose, for example, is an epimer of fructose with a unique structural makeup that prevents it from being absorbed by humans when consumed. Tagatose (immobilised α -galactosidase) is a further illustration of immobilized-enzyme-based sweeteners.