Enzyme Engineering
ISSN: 2329-6674

Khan, Enz Eng 2018, 7:1
DOI: 10.4172/2329-6674.1000163

Mini Review Open Access

Enzyme Technology - An Emerging Trend in Biotechnology

Khan NT*

Faculty of Life Sciences and Informatics, Department of Biotechnology, Balochistan University of Information Technology Engineering and Management Sciences, (BUITEMS), Quetta, Pakistan

***Corresponding author:** Dr. Nida Tabassum Khan, Faculty of Life Sciences and Informatics, Department of Biotechnology, Balochistan University of Information Technology Engineering and Management Sciences, (BUITEMS), Quetta, Pakistan, Tel: 03368164903; E-mail: nidatabassumkhan@yahoo.com

Rec date: 30 June 2018; Acc date: 11 July 2018; **Pub date:** 16 July 2018

Abstract

Enzymes are biological molecules with a definite structural organization that influence their catalytic function. Currently enzymes are being employed in industrial biotechnology for numerous purposes for the production of novel and sustainable products at a speedy rate. Enzyme technology encompasses modification of enzyme structure or its catalytic function to yield novel metabolites or to take part in new reaction pathways. This technology enables the commercial synthesis of numerous enzymes with diverse applications in food processing and preservation, detergents, textile industry, leather industry, paper industry, medicine etc.

Keywords: Cross linking; Biocatalysis; Entrapment; Proteases; Pegadamase bovine

Introduction

Enzyme technology is primarily engaged in the production, isolation, purification and use of enzymes either in the soluble or immobilized form, for the benefit of humankind [1]. With the advancements in, recombinant DNA technology, enzyme engineering produces more effective and diverse group of enzymes with useful applications in microbiology, biochemistry, diagnostics, therapeutics, biocatalysis, structural biology etc. [2]. The overall objective of this emerging technology is to produce unique sustainable products with specific function to fulfill the need of growing population [3].

Literature Review

Objectives of enzyme engineering

- Fabrication of high value specific products by superior enzyme
- To yield greater concentration of enzymes.
- Assembly of synthetic drugs, peptides and proteins
- Producing enzymes with unique properties such as ability to function under extreme environmental conditions
- Alteration in enzyme properties to produce the desired function such as kinetic features of enzyme-turnover, thermal stability, enzyme activity in nonaqueous solvent, reaction/substrate specificity, subunit structure etc. [4-7].

Classification of enzymes

Enzymes classification nomenclature comprises of about 4000 enzymes [8]. Given below is a table indicating enzyme classification (Table 1) [9-12].

Functional capabilities of enzymes is determined by their structure [13]. Active sites of enzymes are the sites for their substrate specific catalytic function, while the rest of the protein acts as scaffolding [14].

Class	Properties
Oxidoreductases	Co substrate required [8]
Isomerases	One substrate reaction [9]
Ligases	Requires ATP as co substrate [10]
Transferases	Two substrates reaction [11]
Hydrolases	Two substrates reaction [12]

Table 1: Enzyme classification.

Given below in Table 2 is list of organisms and their relative contribution in the production of commercial enzymes.

Organism	Relative contribution
Fungi	60% [15]
Bacteria	24% [16]
Yeast	4% [17]
Streptomyces	2% [18]
Higher animals	6% [19]
Higher plants	4% [20]

Table 2: List of organisms and their relative contribution in enzyme production.

Discussion

Enzyme production technology

The basic steps taken for enzyme production includes:

1. **Organism selection:** Selection of organism depends on the ability of microorganism to yield increased concentration of desired enzyme in a short time period with decreased amounts of

secondary metabolites [15-21]. Microbial inoculums introduced in sterilized liquid medium for fermentation, providing optimal growth conditions such as pH, temperature, O2 supply, nutrient [22].

2. **Isolation and purification of enzyme:** Desired enzyme produced may be excreted into the culture medium or may be present within the microbial cells is recovered and purified by cell disruption techniques and downstream processing respectively ensuring minimal loss of enzyme activity [23].
3. **Immobilization of enzyme:** Immobilization of enzyme is achieved on cellulose, polyacrylamide, starch and beads etc., [24] by the following methods:

- **Adsorption:** It involves the attachment of enzyme molecule on an inorganic or organic inert solid support such as silica gel, beads or glass, starch, cellulose etc., by forming weak van dar Waals forces or hydrogen bonding. Later enzymes are removed by slight alterations in pH, ionic strength or temperature [25].
- **Cross linking:** Enzyme can be immobilized by forming cross-linkage to another chemical such as cellulose or glyceraldehydes but it might cause denaturation of enzyme [26].
- **Entrapment:** Enzymes can be immobilized by physical entrapment inside a mesh, capsule or a gel matrix of an inert material such as gelatin, polyacrylamide gel, starch, collagen, silicone, cellulose and rubber [27].
- **Covalent binding:** Immobilization of the enzymes by means of covalent bonding with the support providing the strongest enzyme-support interaction [28].

Applications of enzyme technology

Textile industry

- Amylases enzyme is used as softening agents for starched clothes.
- Cellulases is useful for fabric finishing and often used for better dye uptake in cotton [29,30].

Leather industry

- Proteolytic enzymes is used in dehairing of the skin and for softening /plumping of dehaired skin [31].

Detergent industry

- Proteases is efficient in removing protein stains such as grass, blood, egg and human sweat.
- *Lipases* can easily break down lipid and protein based stains.
- Amylases is efficient in removing starch-based residues.
- Cellulase used in detergent causing restoring fibre smoothness, its original color and
softening [32-34].

Pharmaceutical industry

- Pegadamase bovine is employed for SCID treatment .
- Pancreatic enzymes is effective against fat malabsorption in HIV patients.
- Spinal injuries could be treated with chondroitinases .
- Hyaluronidase aids in the rebuilding of damaged nerve tissues.
- Lysozyme is used as an antibacterial agent and also possess activity against HIV.
- Human melanoma and hepatocellular carcinomas could be inhibited by PEGylated arginine deaminase [35-40].

Food industry

- Amylase is added to the dough to ensure its quality and increased shelf life.
- Enzymes is also employed in cheese making by milk coagulation.
- Proteolytic enzyme help to increase the shelf life of meat and sea food.
- Lipases used to control the lipid content of food products.
- Glucose oxidase and catalase are used as food preservative agents.
- Renin is used in the manufacture of cheese.
- Lactase enzymes is applied in the making of ice cream, yoghurt and frozen and invertase in the making of chocolate covered berries and candies.
- Glucose isomerase is used for the production of fructose and high fructose syrups [41-48].

Conclusion

Thus the enzyme technology is an emerging trend in biotechnology which employs the production of diverse functional enzymes for numerous valuable purposes in different areas.

References

1. Chaplin MF, Bucke C (1990) Enzyme technology. Cambridge University Press, Cambridge, UK.
2. Van Beilen JB, Li Z (2002) Enzyme technology: An overview. Curr Opin Biotechnol 13: 338-344.
3. Buchholz K, Kasche V, Bornscheuer UT (2012) Biocatalysts and enzyme technology. (2nd edn), John Wiley & Sons, UK.
4. Chiang SJ (2004) Strain improvement for fermentation and biocatalysis processes by genetic engineering technology. J Ind Microbiol Biotechnol 31: 99-108.
5. Whitehurst R J, Van Oort M (2009) Enzymes in food technology. (2nd edn), John Wiley & Sons, UK.
6. Garcia-Galan C, Berenguer-Murcia Á, Fernandez-Lafuente R, Rodrigues RC (2011) Potential of different enzyme immobilization strategies to improve enzyme performance. Adv Synth Catal 353: 2885-2904.
7. Xie T, Wang A, Huang L, Li H, Chen Z (2009) Recent advance in the support and technology used in enzyme immobilization. Afr J Biotechnol 8.
8. NC-IUBMB (1965) Enzyme nomenclature: Recommendations of the Nomenclature Committee of the International Union of Biochemistry and Molecular Biology on the nomenclature and classification of enzymes. University of London.
9. Tipton K, Boyce S (2000) History of the enzyme nomenclature system. BMC Bioinformatics 16: 34-40.
10. OH AA (2017) Classification of enzymes, Biocatalysis. World Scientific Publishing Europe, UK.
11. Aszalos AA (1978) Classification of Enzymes. Enzymes in Anesthesiology Springer, New York, NY, USA pp: 71-88.
12. International Union of Biochemistry. Standing Committee on Enzymes (1965) Enzyme nomenclature. Elsevier Publishing Company, Amsterdam, Netherlands.
13. Bergmann M (2006) A classification of proteolytic enzymes. Adv Enzymol Relat Areas Mol Biol 2: 49-68.
14. Carter P, Wells JA (1987) Engineering enzyme specificity by substrate-assisted catalysis. Science 237: 394-399.
15. Chapin FS, Matson PA, Mooney HA (2002) Terrestrial decomposition: Principles of terrestrial ecosystem ecology. Springer New York, USA. pp: 151-175.

16. Howard RL, Abotsi ELJR, Van Rensburg EJ, Howard S (2003) Lignocellulose biotechnology: Issues of bioconversion and enzyme production. Afr J Biotechnol 2: 602-619.
17. Steen EJ, Chan R, Prasad N, Myers S, Petzold CJ (2008) Metabolic engineering of Saccharomyces cerevisiae for the production of n-butanol. Microb Cell Fact 7: 36.
18. Bailey JE (1991) Toward a science of metabolic engineering. Science 252: 1668-1675.
19. Demain AL, Vaishnav P (2009) Production of recombinant proteins by microbes and higher organisms. Biotechnol Adv 27: 297-306.
20. Himmel ME, Ding SY, Johnson DK, Adney WS, Nimlos MR, et al. (2007) Biomass recalcitrance: Engineering plants and enzymes for biofuels production. Science 315: 804-807.
21. Ishige T, Honda K, Shimizu S (2005) Whole organism biocatalysis. Curr Opin Chem Biol 9: 174-180.
22. Jasson V, Jacxsens L, Luning P, Rajkovic A, Uyttendaele M (2010) Alternative microbial methods: An overview and selection criteria. Food Microbiol 27: 710-730.
23. Bonnerjea J, Oh S, Hoare M, Dunnill P (1986) Protein purification: The right step at the right time. Nat. Biotechnol 4: 954-958.
24. Brena BM, Batista-Viera F (2006) Immobilization of enzymes, In: Immobilization of enzymes and cells. Humana Press, New York, USA. pp: 15-30.
25. Zaborsky OR (1977) Immobilization of enzymes by adsorption, In: Biomedical applications of immobilized enzymes and proteins. Springer, Boston, MA, USA. pp: 37-46.
26. Cao L, Van Rantwijk F, Sheldon RA (2000) Cross-linked enzyme aggregates: A simple and effective method for the immobilization of penicillin acylase. Org Lett 2: 1361-1364.
27. Avnir D, Braun S, Lev O, Ottolenghi M (1994) Enzymes and other proteins entrapped in sol-gel materials. Chem Mater 6: 1605-1614.
28. Bickerstaff GF (1997) Immobilization of enzymes and cells. In: Immobilization of enzymes and cells. Humana press, New York, USA. pp: 1-11.
29. Lund H, Nilsson TE, Pickard T (2000) U.S. Patent No. 6,077,316, Washington DC, Patent and Trademark Office, USA.
30. Bajaj P (2002) Finishing of textile materials. J Appl Polym Sci 83: 631-659.
31. Dayanandan A, Kanagaraj J, Sounderraj L, Govindaraju R, Rajkumar GS (2003) Application of an alkaline protease in leather processing: An ecofriendly approach. J Clean Prod 11: 533-536.
32. Najafi MF, Deobagkar D, Deobagkar D (2005) Potential application of protease isolated from Pseudomonas aeruginosa PD100. Electron J Biotechnol 8: 197-203.
33. Houde A, Kademi A, Leblanc D (2004) Lipases and their industrial applications. Appl Biochem Biotechnol 118: 155-170.
34. Ito S, Kobayashi T, Ara K, Ozaki K, Kawai S, et al. (1998) Alkaline detergent enzymes from alkaliphiles: Enzymatic properties, genetics, and structures. Extremophiles 2: 185-190.
35. Kaur R, Sekhon BS (2012) Enzymes as drugs: An overview. Indian J Pharm Educ 3: 29.
36. Carroccio A, Guarino A, Zuin G, Verghi F, Berni Canani R, et al. (2001) Efficacy of oral pancreatic enzyme therapy for the treatment of fat malabsorption in HIVinfected patients. Aliment Pharmacol Ther 15: 1619-1625.
37. Bradbury EJ, Moon LD, Popat RJ, King VR, Bennett GS, et al. (2002) Chondroitinase ABC promotes functional recovery after spinal cord injury. Nature 416: 636-640.
38. Nakai J (1956) Dissociated dorsal root ganglia in tissue culture. Am J Anat 99: 81-129.
39. Chan DI, Prenner EJ, Vogel HJ (2006) Tryptophan-and arginine-rich antimicrobial peptides: Structures and mechanisms of action. Biochim. Biophys. Acta 1758: 1184-1202.
40. Ensor CM, Holtsberg FW, Bomalaski JS, Clark MA (2002) Pegylated arginine deiminase (ADI-SS PEG20, 000 mw) inhibits human melanomas and hepatocellular carcinomas in vitro and in vivo. Cancer Res 62: 5443-5450.
41. Van Der Maarel MJ, Van Der Veen B, Uitdehaag JC, Leemhuis H, Dijkhuizen L (2002) Properties and applications of starch-converting enzymes of the α-amylase family. J Biotechnol 94: 137-155.
42. Scott R, Scott JE, Robinson RK, Wilbey RA (1998) Cheesemaking practice. Springer Science & Business Media, Boston, MA, USA.
43. Ashie INA, Smith JP, Simpson BK, Haard NF (1996) Spoilage and shelf - life extension of fresh fish and shellfish. Crit. Rev. Food Sci Nutr 36: 87-121.
44. Hasan F, Shah AA, Hameed A (2006) Industrial applications of microbial lipases. Enzyme Microb Technol 39: 235-251.
45. Bankar SB, Bule MV, Singhal RS, Ananthanarayan L (2009) Glucose oxidase—An overview. Biotechnol Adv 27: 489-501.
46. Broome MC, Limsowtin GKY (1998) Milk coagulants. Aust J Dairy Technol 53: 188.
47. Simpson BK, Rui X, Jie XJ (2012) Enzyme-assisted food processing, In: Green technologies in food production and processing. Springer, Boston, MA, USA. pp: 327-361.
48. Bhosale SH, Rao MB, Deshpande VV (1996) Molecular and industrial aspects of glucose isomerase. Microbiol Rev 60: 280-300.