Biochemistry & Physiology: Open Access

Kuddus, Biochem Physiol 2015, 4:1
DOI: 10.4172/2168-9652.1000e132

Editorial Open Access

Cold-active Microbial Enzymes

Mohammed Kuddus*

Department of Biochemistry, University of Hail, Hail - 2440, Kingdom of Saudi Arabia

Absolutely the largest proportion of the Earth's biosphere is consisting of microorganisms that thrive in cold environments and known as psychrophiles/psychrotrophs. Their ability to survive in the cold environments is based on the capacity to synthesize cold-adapted enzymes, such as amylases, proteases, lipases, pectinases, cellulases etc., along with other specific characteristics. Enzymes are essential constituents of all forms of life on the Earth, including prokaryotes, fungi, plants and animals. Commercial applications of microbial enzyme are attractive due to the relative ease of large-scale production as compared to enzymes from plants and animals. At present, only ~2% of the microorganisms on the Earth have been commercially exploited and amongst these there are only a few examples of psychrophiles and psychrotrophs [1]. Around 85% of the Earth is occupied by cold ecosystems including the ocean depths, polar and alpine regions. Out of which ~70% is covered by oceans that have a constant temperature of 4-5 °C, irrespective of the latitude. Microbes growing at low temperature regions are important for their metabolic contribution in the ecosphere as well as for their enzymes with potential industrial applications [2]. During the past decade it has been recognized that cold-adapted microorganisms provide a wide biotechnological potential over the use of organisms and their enzymes which operate at higher temperatures [3,4]. Cold-adapted microorganisms are potential source of cold-active enzymes which had high catalytic efficiency with low and moderate temperatures at which homologous mesophilic enzymes are not active, and are thermolabile [5]. The potentials of cold-active enzymes along with their producing organisms have been reviewed time to time [3,4,6]. Cold-active enzymes confer low activation energies and high activities at low temperature which are favorable properties for the production of relatively insubstantial compounds. The application of cold-active enzymes enables lowering of temperature without loss of efficiency, which results in saving of energy consumption and have great potential for various biotechnological processes [7]. The low temperature stability of cold-active enzymes has been regarded as the most important characteristics for use in the industry because of considerable progress towards energy savings but unfortunately these enzymes have largely been overlooked. Now this situation is changing which recently fascinated the scientific community to focus in many fields, such as clinical, medicinal and analytical chemistry, as well as their widespread biotechnological and industrial applications such as food processing, additive in detergents and food industries, waste-water treatment, biopulping, environmental bioremediation in cold climates, biotransformation and molecular biology applications.

Only within the past few years it has been recognized that the catalytic ability of cold-active enzymes and their producing organisms offers huge industrial and biotechnological potential [3,4,6,8-12]. In detergent industry, a decrease in energy consumption and increase the life of clothe are obvious benefits of cold washing. For this purpose enzymes should be active and stable at low temperature [13]. There are several possible applications of cold-adapted enzymes in the food industry [2]. The use of psychrophilic enzymes can be advantageous not only for their high specific activity, thereby reducing the amount of enzyme needed, but also for their easy inactivation. Food processing at low temperatures minimizes undesirable chemical reactions as well as bacterial contamination. Cold-active proteases have found extensive application in the textile industry for improving production methods and fabric finishing. It can also modify the surface of wool and silk fibers to provide new and unique finishes [14]. Psychrophilic microorganisms have also been proposed for the bioremediation of polluted soils and waste-waters during the winter in temperate countries, when the degradative capacity of the endogenous microflora is impaired by low temperatures. However, bioaugmentation and inoculation of contaminated environments with specific cold-adapted microorganisms in mixed cultures should help to improve the biodegradation of recalcitrant chemicals. In molecular biology, psychrophilic enzymes are advantageous to obtain irreversible enzyme inactivation by mild heat treatment without interference with subsequent reactions. Protein expression systems operating at low temperatures are also an important achievement in the field because low temperature can prevent the formation of inclusion bodies and protects heat-sensitive gene products, although these systems are still very rare.

Analysis of the literature reveals that cold-active enzymes offer several advantages over mesophilic/thermophilic enzymes. Most of the cold-active enzymes are characterized by their high catalytic efficiency at low and moderate temperatures at which homologous mesophilic enzymes are not active [15]. Due to this characteristic, cold-active enzymes are useful in biotechnology in order to shorten process times, save energy costs, decrease the enzyme concentration required, prevent undesired chemical transformations, and the loss of volatile compounds. However, more extensive effort is required to overcome several bottlenecks such as high enzyme cost, low stability and the low biodiversity of psychrophilic/psychrotrophic microbes explored so far. To fulfill the demand of industries, enzyme technology needs extension of biotechnological approach in terms of both quality and quantity. Various molecular approaches such as protein engineering, r-DNA technology and metagenomic approach could be established to achieve qualitative and quantitative improvements and develop radically novel cold-active enzymes. Genetically improved strains, appropriate for specific cold-active enzyme production, would play an important role in various industrial and biotechnological applications. In the near future, the potential value of cold-adapted enzymes is likely to lead to a greater annual market than for thermo-stable enzymes.

***Corresponding author:** Mohammed Kuddus, Department of Biochemistry, University of Hail, Hail - 2440, Kingdom of Saudi Arabia, Tel: +966 504984419; Fax: +966 65317140; E-mail: mkuddus@gmail.com

Received February 14, 2015; **Accepted** February 16, 2015; **Published** February 23, 2015

Citation: Kuddus M (2015) Cold-active Microbial Enzymes. Biochem Physiol 4: e132. doi: 10.4172/2168-9652.1000e132

References

1. Gomes J, Steiner W (2004) Extremophiles and Extremozymes. Food Technol Biotechnol 42: 223–235.

2. Margesin R, Schinner F (1994) Properties of cold adapted microorganisms and their potential role in biotechnology. J Biotechnol 33: 1-14.

3. Georlette D, Blaise V, Collins T, D'Amico S, Gratia E, et al. (2004) Some like it cold: biocatalysis at low temperatures. FEMS Microbiol Rev 28: 25-42.

4. Margesin R, Feller G, Gerday C, Russell N (2002) Cold-Adapted Micro-organisms: Adaptation strategies and biotechnological potential. In: Bitton G (Eds)The Encyclopedia of Environmental Microbiology. (Vol 2), John Wiley & Sons, New York.

5. Margesin R, Dieplinger H, Hofmann J, Sarg B, Lindner H (2005) A cold-active extracellular metalloprotease from *Pedobacter cryoconitis* - production and properties. Res Microbiol 156: 499–505.

6. Feller G, Gerday C (2003) Psychrophilic enzymes: hot topics in cold adaptation. Nat Rev Microbiol 1: 200-208.

7. Kuddus M, Ramteke PW (2008) Purification and properties of cold-active metalloprotease from *Curtobacterium luteum* and effect of culture conditions on production. Chin J Biotech 24: 2074-2080.

8. Gerday C, Aittaleb M, Bentahir M, Chessa JP, Claverie P, et al. (2000) Cold-adapted enzymes: From fundamentals to biotechnology. Trends Biotechnol 18: 103–107.

9. Eichler J (2001) Biotechnological uses of archaeal extremozymes. Biotechnol Adv 19: 261–278.

10. Gupta R, Beg QK, Lorenz P (2002) Bacterial Alkaline Proteases: Molecular approach and industrial application. Appl Microbiol Biotechnol 59: 15-32.

11. Cavicchioli R, Siddiqui KS, Andrews D, Sowers KR (2002) Low-temperature extremophiles and their applications. Curr Opin Biotechnol 13: 253-261.

12. Burg BV (2003) Extremophiles as a source for novel enzymes. Curr Opin Microbiol 6: 213–218.

13. Kuddus M, Ramteke PW (2011) Production optimization of an extracellular cold-active alkaline protease from *Stenotrophomonas maltophilia* MTCC 7528 and its application in detergent industry. Afr J Microbiol Res 5: 809-816.

14. Najafi MH, Deobagkar D, Deobagkar D (2005) Potential application of protease isolated from *Pseudomonas aeruginosa* PD100. Electronic J Biotech 8: 197-203.

15. Kuddus M, Ramteke PW (2008) A cold-active extracellular metalloprotease from *Curtobacterium luteum* (MTCC 7529): enzyme production and characterization. J Gen Appl Microbiol 54: 385-392.