International Journal of Biotechnology and Biomedical Sciences
p-ISSN 2454-4582, e-ISSN 2454-7808, Volume 3, Issue 1; January-June, 2017 pp. 58-60

http://www.krishisanskriti.org

Enzyme Biotechnology for Sustainable Development

Amrita Kumari Panda[1] and Satpal Singh Bisht[2]

[1]*Department of Biotechnology, Sarguja University, Ambikapur-497001, Chhattisgarh, India*
[2]*Department of Zoology, Kumaun University, Nainital-263002, Uttarakhand, India*
E-mail: [1]itu.linu@gmail.com, [2]sps.bisht@gmail.com

Abstract—*Sustainable development aims to facilitate and support strategic changes in resource exploitation for aligning food products with current and future consumers. Industrial sustainability achieved due to the array of emerging genomics, proteomics and metabolomics technologies. Genetic engineering techniques have been used to produce many improved enzymes and biocatalysts with high stability and specificity from their natural counterparts. The demand of novel industrial enzymes can be achieved by fishing out better enzymes by molecular screening of microbes or by improving existing enzymes by protein engineering. The use of thermophilic microorganisms as source of enzyme trends towards sustainable industrial development because of new application fields and new enzymes. Now a days the limitations of isolation techniques of thermophiles overcome by metagenomics, a new technology for discovery of genes by in silico approach and their commercial exploitation.*

Keywords: *Industrial sustainability, Enzyme Biotechnology, Thermophiles, Metagenomics*

1. INTRODUCTION

Sustainable development requires a framework for integrating environmental policies and developmental strategies in a global context [1]. Increased sustainability considerations would shape future technological, socio-economic, political and cultural changes to define the boundaries of what is acceptable [1]. Sustainability enables individuals and communities in underdeveloped regions of the world to raise living standards through profitable products with minimizing adverse environmental effects. By 2030 the World population is expected to be 8.1 billion, to meet the demand of more people with less available arable land, fewer non renewable resources and less water, the biotechnology would be the only emerging technology that can change the way of energy, chemical and other products. The application of biotechnology across various industry sectors has invariably led to both economic and environmental benefits including less expensive processing, enhanced product quality, entirely new products and environmentally sustainable processing relative to conventional operations [2].

2. ROLE OF ENZYME BIOTECHNOLOGY

Enzymes are being used in numerous new applications in the food, feed, agriculture, paper, leather and textiles industries resulting in significant cost reductions [3]. Enzymes can often replace chemicals or processes that offer an eco-friendly issue. For example, enzymes can:

- Replace extended treatment with caustic soda at high temperature in the starch processing industry and alkalis or oxidizing agents in fabric designing.
- Elimination of the use of sodium sulfide, simplification of the process of pre-tanning and de-haring in tanneries.
- Enzymes can be used instead of chlorine bleach for removing stains on cloth. The use of enzymes allows washing at low temperature thus saves energy, reduced level of surfactants and permits the cleaning of clothes in the absence of phosphates.
- Replacement of pumice stones for “stonewashing” jeans by a cellulose-based treatment include less damage of fibers.
- Improve feed efficiency.

Many commercially available enzymes are too costly for the intended applications, even if they can be recovered and reused by immobilization. Therefore, reduced enzyme prices may dramatically increase the number of applications. Recent trends in industrial biotechnology includes pproduction of microbial enzymes including animal and plant enzymes by genetically modified microorganisms [3] or replacement of thermozymes from thermophilic microorganisms for mesophilic enzymes or chemicals. World enzyme market is expected to reach $ 5.4 billion by 2020.

The world food and beverages enzymes demand is expected to be responsible for 40.1% of the world industrial enzyme demand in 2020 (Fig. 1), accounting for $2,520 of $6,280 million dollars of the world industrial enzyme market.

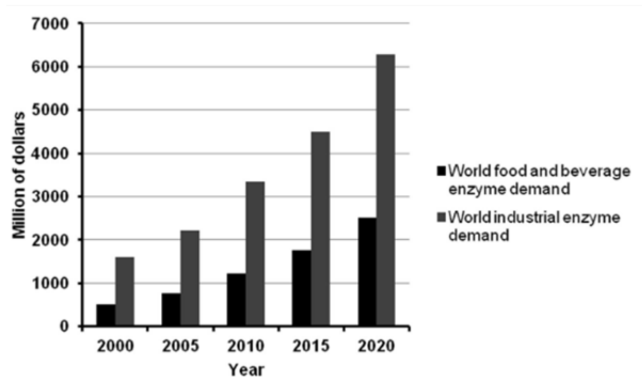

Fig. 1. Global enzyme demand, 2000-2020 (Source The Freedonia Group Inc., World Enzymes to 2015).

3. THERMOPHILES AS A SOURCE OF NOVEL ENZYME FOR INDUSTRIAL BIOTECHNOLOGY

Thermophiles are well-known to produce many industrially important enzymes [4] i.e. thermophilic amylase and glycosidases are used in glucose and fructose production as sweeteners, starch processors, saccharifying enzymes, etc. [5]. Xylanases are used for paper bleaching [6]; lipase is applied for waste water treatment and detergent formulation [7] and proteases in food processing, amino acids production and detergent manufacturing [8]. DNA polymerases from thermophilics are used in genetic engineering and molecular biology [9] and dehydrogenases for oxidation reactions [10]. Hence thermophiles can be exploited to produce various thermostable enzymes (Fig. 2).

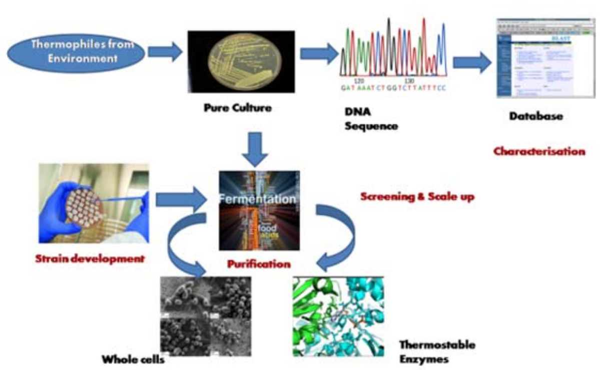

Fig. 2: Schematic presentation of trends in enzyme engineering and technology

3.1 Recently identified enzymes from thermophiles

Currently increased research interest on thermophilic microorganisms is due to the fact that the thermozymes can withstand the harsh industrial environment and many advantages over the enzymes. Some of the industrially important genes recently identified from thermophiles and published includes novel lipase from novel thermophilic bacilli isolated from Armenian geothermal springs [11], novel amine transferases from hot spring metagenome [12]Type IIP restriction endonuclease TfoI from Polok hot spring, Sikkim, India [13], many biotechnologically important enzymes such as proteases, amylases, cellulases from geothermal areas of Turkey [14], novel α-galactosidases from the thermophilic bacterium *Dictyoglomus thermophilum* [15], antioxidative compounds from *Meiothermus* sp. and *Thermus* sp. of Paniphala hot spring, India [16].

4. WORK AT THE AUTHOR'S LABORATORY

A 750-bp lipase gene from *Brevibacillus* sp. AK-P2 from a hot spring of Orissa, India was cloned and sequenced. Multiple sequence alignment (MSA) revealed that methionine residue (M) in the oxyanion hole consensus sequence, frequent occurrence of AXXXA motif, higher percentage of Alanine (A) in this thermophilic *Brevibacillus* lipase gene attributed towards its thermostabilization.

5. CONCLUSIONS

Recent advances in enzyme biotechnology through functional metagenomics from various unexplored environmental niches and whole genome sequencing approaches may lead to novel effective green technology that use lesser quantities of chemicals to produce more yield.

6. ACKNOWLEDGEMENTS

This work was supported by grant of SERB, Govt. of India, New Delhi.

REFERENCES

[1] Hall, S., Roome, N., "Strategic choices and sustainable strategies", in Groenewegen P, editor. *The greening of industry: Resource guide and bibliography*. Washington, DC7 Island Press, 1996, pp. 9.

[2] Gavrilescu, M., and Chisti, Y., "Biotechnology—a sustainable alternative for chemical industry", *Biotechnology advances*, 23(7), 2005, pp. 471-499.

[3] van Beilen, J. B., and Li, Z., "Enzyme technology: an overview", *Current Opinion in biotechnology*, 13(4), 2002, pp. 338-344.

[4] Mishra, S. S., Ray, R. C., Rosell, C. M., and Panda, D., "Microbial Enzymes in Food Applications", in *Microbial Enzyme Technology in Food Applications*, 2017,1.

[5] Di, Lernia., I., Morana, A., Ottombrino, A., Fusco, S., Rossi, M. and De Rosa, M., "Enzymes from *Sulfolobus shibatae* for the production of trehalose and glucose from starch", *Extremophiles*, 2, 1998, pp. 409–416.

[6] Ishida, M., Yoshida, M. and Oshima, T., "Highly efficient production of enzymes of an extreme thermophile, *Thermus thermophilus*: A practical method to overexpress GC-rich genes in *Escherichia coli*" *Extremophiles*, 1, 1997, pp. 157–162.

[7] Becker, P., Abu Reesh, I., Markossian, S., Antranikian, G. and Markl, H., "Determination of the kinetic parameters during continuous cultivation of the lipase producing thermophile

Bacillus sp. IHI-91 on olive oil", *Applied Microbiology and Biotechnology*, 48, 1997, pp. 184–190.

[8] Hough, D.W. and Danson, M.J., "Extremozymes", *Current Opinion in Chemical Biology*, 3, 1999, pp. 39–46.

[9] Madigan, M.T. and Marrs, B.L., "Extremophiles" *Scientific American*, 4, 1997, pp. 66–71.

[10] Tao, H. and Cornish, V.W. "Milestones in directed enzyme evolution", *Current Opinion in Chemical Biology*, 6, 2002, pp. 858–864.

[11] Shahinyan, G., Margaryan, A., Panosyan, H., and Trchounian, A., "Identification and sequence analyses of novel lipase encoding novel thermophillic *Bacilli* isolated from Armenian geothermal springs", *BMC microbiology*, 17(1), 2017, pp. 103.

[12] Ferrandi, E. E., Previdi, A., Bassanini, I., Riva, S., Peng, X., and Monti, D., "Novel thermostable amine transferases from hot spring metagenomes". *Applied Microbiology and Biotechnology*, 2017, pp. 1-17.

[13] Kumar, R., Pinnaka, A. K., and Krishnan, B., "TfoI produced by *Tepidimonas fonticaldi* PL17, a moderate thermophilic bacterium, is an isoschizomer of MseI", *Extremophiles*, 21(3), 2017, pp. 523-535.

[14] Baltaci, M. O., Genc, B., Arslan, S., Adiguzel, G., and Adiguzel, A., "Isolation and Characterization of Thermophilic Bacteria from Geothermal Areas in Turkey and Preliminary Research on Biotechnologically Important Enzyme Production", *Geomicrobiology*, 34(1), 2017, pp.53-62.

[15] Schroder, C., Janzer, V. A., Schirrmacher, G., Claren, J., and Antranikian, G., "Characterization of two novel heat-active α-galactosidases from thermophilic bacteria", *Extremophiles*, 21(1), 2017, pp. 85-94.

[16] Mukherjee, T., Bose, S., & Mukhopadhyay, S. K., "Antioxidant properties of the carotenoid extracts of three *Deinococcus–Thermus* phylum bacteria, *Meiothermus* sp. strains RP and TP and *Thermus* sp. strain YY from Paniphala hot spring, India", *Nutrire*, 42(1), 2017, pp. 7.