

Thermozymes: An area of potential research

Research on extremophiles, i.e. organisms able to survive and thrive in extreme environmental conditions, as promising sources of highly stable enzymes (extremozymes) has been active in the present decade¹. The enzymes from organisms adapted to extreme environments called extremozymes have been grouped into various categories such as enzymes that function at high temperatures (thermозymes), high salt levels (halozymes), under alkaline conditions (alkalozymes) and other extreme conditions such as pressure, acidity, etc.

The thermophilic enzymes (thermозymes) have generated wide interest due to their inherent stability and wide applicability. With the discovery of *Thermus aquaticus* by T. D. Brock and his colleagues in 1969, and subsequently, the *Taq* DNA polymerase have brought about a revolution in the field of molecular biology and biotechnology, and focused on the potential of thermozymes.

Thermophilic enzymes are barely active in the temperature range of 20–30°C, but become fully active at temperatures higher than the optimal growth temperatures of other organisms. These enzymes develop unique structural and functional properties of high thermostability and optimal activity at temperatures above 70°C; some of the enzymes discovered are found to be active at temperatures of 110°C and above. Thermophilic enzymes

are more rigid proteins than the mesophilic enzymes, but little work has been done in this area.

Natural environments include hot springs, deep-sea hot sediments and deep geothermally heated oil-containing stratifications. Hydrothermal vents are considered to be potential sources of the thermozymes. Isolation of the organisms is not easy. Microbiologists estimate that <10% of all organisms existing in a given environment is actually cultivable.

Thermozymes that are stable and active at high temperatures offer major biotechnological advantages over their counterparts.

(i) They can be purified easily by heat treatment when expressed in the mesophilic hosts.

(ii) Due to their thermostability, they have high resistance to chemical denaturants, such as organic solvents required for the synthesis of fine chemicals in cases where substrates are poorly water-soluble.

(iii) Enzyme reactions performed at high temperatures allow higher substrate concentrations, lower viscosity, reduction in the risk of contamination and high reaction rates.

In recent years thermophilic proteases, lipases and polymer degrading enzymes such as cellulases, gelatinases and amylases have found their way into biotech-

nological and industrial applications². Thermozymes are natural models of stable proteins and are remarkable tools for innovative biotechnological processes. These enzymes can serve as model systems to be used by the biologists, physicists and chemists to study and understand enzyme evolution, protein thermostability mechanisms, and minimum and maximum temperature limits of enzyme function.

Research on thermozymes and their exploration coupled with better understanding of their structural properties may help in the development of proteins with desired catalytic and thermal properties. This will also lead to the development of better and newer protein engineering strategies and can be exploited for designing a wide range of biotechnological and industrial molecules in the near future.

1. Herbert, R., *Trends Biotechnol.*, 1992, **7**, 349–353.
2. Satyanarayana, T., Raghukumar, C. and Sivaji, S., *Curr. Sci.*, 2005, **89**, 78–90.

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Palynology in India: What is the future?

Palynology is a fascinating science with a multidimensional approach covering almost all branches of botanical sciences. It is segregated into many sub-branches such as: ‘aeropalynology’ dealing with pollen contained in the air and pollen allergy; ‘palaeopalynology’ dealing with fossil pollen which is also useful in interpretation of ancient flora (pollen spectrum is helpful in oil exploration); ‘melissopalynology’ encompassing honey pollen analysis and honey bee flora, including pollination ecology; ‘nutritional palynology’ or pollen chemistry, a subject which elaborates the chemical and nutritional

contents of pollen, both for insects and human beings, and ‘pollen histo-chemistry’ for study of pollen–stigma interaction and incompatibility systems in plants. Besides these, pollen germination, culture and hybridization are other areas of pollen-based research. It may further be emphasized that the new advanced researches encompassing biodiversity, molecular biology, gene-mapping and DNA fingerprinting are all areas depending on the basic unit of reproduction in plants – the pollen. Can we possibly ignore such an integral reproductive entity? The significance of pollen and therefore the

study of pollen grains (palynology) is vital for all plant-based researches.

Palynological studies in India were initiated by Wodehouse in 1935 and reached greater heights with the efforts of subsequent pioneer workers like G. Erdtman and P. K. K. Nair. With the advent of electron microscopy, the subject received a new impetus. Several other palynologists emerged in our country during 1960–90, but soon they switched over to other areas due to lack of infrastructure. Slowly the subject dwindled to a few pockets of the National Research Laboratories by the end of 20th century.

CORRESPONDENCE

Thereafter all attempts of the pioneer workers were thwarted and also adversely affected the outputs, mainly in terms of publications.

The present time is experiencing a drastic collapse, both qualitative and quantitative, paralleled to reduction in the number of workers in palynology, the basic reason being limiting factors such as scarcity of employment opportunities in this area because all recruitment policies are now oriented towards modern branches such as molecular biology, biodiversity and conservation. Palynology

now lies underutilized in the hands of a few saviours. Lack of manpower is a serious barrier in quality production as palynologists find it difficult to adopt modern techniques such as pollen fracturing, TEM-based pollen ontogeny studies, studies on male sterility and genetic basis of disease resistance contained in pollen. Such an area involves biotechnological assistance coupled with palynology, since pollen itself is a pool of genetic variation and studies involving DNA fingerprinting of male-specific character contained in pollen can provide informa-

tion on the plant as a whole. Pollen-based research is actually a plant-based research as pollen is a representative unit of the plant with pure and complete set of genetic characters. This is a subject which needs attention and time has come when 'pollen biotechnology' should emerge as a new discipline.

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Values in science

The recent case of alleged misconduct in science at the National Centre for Cell Science (NCCS), Pune raises certain issues on ethics of practising science which often lead to conflict of interest among different scientific workers. In the recent past such controversies are on the rise reflecting a deterioration of ethical, moral and social values in every sphere of life and scientific community is no exception. Science is the search for truth and scientific endeavours that lead to half truths and fallacies are worse than doing no science. Basically values intersect with science in three ways. First, epistemic values which guide scientific research itself; secondly, the scientific enterprise is always embedded in some particular culture and values enter sci-

ence through its individual practitioners consciously or otherwise; thirdly, values emerge from science both as a product and process and may be distributed more broadly in the culture of an individual or a society. Actually a variety of values promote more robust knowledge where they intersect. The social values or research ethics are not always followed in science but they remain very important. The pursuit of scientific knowledge implies a certain set of characteristically 'scientific values', but the relevance of other values in the practice of science is thereby not eclipsed. In the case of NCCS, the problem of misconduct was independently taken up by the Society of Scientific Values (SSV) which rightly deserves applause for exposing the fault

and it is high time that they should be given more teeth and armoury to fight the deteriorating ethical and moral values of scientific research and to test the reality of fraud and misconduct which is spreading like 'cancer' in many institutions and specially among those who want short-term gains. Investigations into misconduct must quickly resolve the case and should not follow the path of politicians/bureaucrats whose cases linger in different trial courts for years. For the scientific community, once 'alleged' is always 'alleged'.

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The march of neophilia: Time for the academic world to be cautious

The attraction for anything new has proved to be an important driving force for human civilizations through centuries. Newer discoveries and inventions that have changed the world have often been inspired by this deep inner desire for newer things. The term 'neophilia' that is now being used in different contexts has got a slightly different connotation. Though literally the meaning of the word 'neophilia' is attraction for the new, it is now being accepted by sociologists that this term can be used not to talk about

the attraction for the new, but obsession for anything new. And this is not the same desire that used to drive people towards newer inventions and discoveries. This attitude considered to be somewhat alarming in the Western society is probably taking its root in a developing country like India in a somewhat different fashion.

In a news item published in *New Scientist*¹, it has been pointed out that the number of mobile phones discarded by Americans every year has reached about 100 million. This implies that people are

probably changing their mobile phones more than once in a year and whenever new models come out, a section of people, mostly young and in their twenties, is grabbing them. The manufacturers and those associated with the promotion of these new models are thus bound to benefit. The discarded phones on the one hand are causing environmental hazard, since mobile phones contain parts that have heavy and toxic metals. On the other hand, the whole exercise has a significant impact on the economy. Possibly