Extremophilic bacteria

What causes stress for some, actually speeds others like extremophilic bacteria up. They love it hot, sour or salty, toxic substances like heavy metals also do them good and even give them energy. As molecular and systems biology techniques get better and better, industry is also becoming increasingly interested in these exotic organisms. What potential does knowing the biochemistry of extremophilic bacteria have for the pharmaceutical, cosmetics and sanitary articles industries? Whatever the answer might turn out to be, there is certainly a growing trend towards using extremophilic microbes in academic and industrial research.

The metabolism of bacteria and algae that live in hot volcanic springs, the Dead Sea, contaminated soils or the Arctic pack ice has adapted to extreme habitats and always manages to glean something positive from such environments. Life is able to thrive almost anywhere on Earth. The metabolism of extremophilic microorganisms generates a rich source of molecules that enable the bacteria to live in extreme, virtually inhabitable areas. Over the last few years, the biotech industry has also recognized the potential of this barely exploited "gold mine" and is in a real gold-rush mood.

Energy-saving and sustainable

There appears to be a fundamental change in the way industry is thinking: the industrial synthesis of numerous substance classes is now frequently done in bioreactors rather than chemical refineries. Innovative materials include basic and fine chemicals produced from plant raw materials, biopolymers used for the production of plastics, and environmentally friendly biofuels. "Biocatalyser" is the keyword of the future. Biocatalysers are enzymes produced with living organisms and which mediate defined synthesis steps. Besides being used in the production of fine chemicals, biocatalysers are also increasingly being used in the production of mass chemicals. Bioreactors of 500 m^3 or more are already being used for the production of the flavour enhancer L-glutamate, the feed supplement L-lysine, antibiotics, vitamins, citric and lactic acid.

The substitution of petrochemical production steps with biotechnological methods could potentially reduce energy use and facilitate the shift to production methods that use renewable raw materials. The BMBF plans to set aside up to 100 million euros in funding for its "Industrial Biotechnology Innovation Initiative" for the next five to ten years. As molecular high-throughput methods and better cultivation methods have been developed over the last few years, academic and industry researchers have increasingly focused on the use of exotic bacteria and fungi.

Pink fish meat and UV skin protection

Their tolerance to extreme chemical and physical environments makes the biomolecules of extremophilic microorganisms interesting for numerous industrial synthesis steps that need to be carried out at specific high or low temperatures or pressure, in the absence of oxygen or in other "exotic" chemical environments.

Extremophilic organisms have broken many records for tolerance to different conditions:

Cold: -15°C - microalgae (Eukarya)

Heat: 113°C - Pyrolobus fumarii (Archaea)

Acidic: pH 0.7 - Picrophilus torridus (Archaea)

Alkaline: pH >10 - Natronobacterium pharaonis (Archaea)

Irradiation: >3 Mrad - Deinococcus radiodurans (Bacteria)

Salt: >5 M - Halobacteriaceae (Archaea)

Methane consumers and stress-free plants

Extremophilic microorganisms might in future help turn society's vision of greater environmental protection into reality: the use of methane-consuming bacteria to counteract the greenhouse effect and thermophilic bacteria for the fermentation of green waste at temperatures of 100°C or more. In addition, a detailed understanding of the molecular and metabolic biology of extremophilic microorganisms also has the potential to help make agriculturally relevant plants more resistant to high salt concentrations, heavy metal contaminations or drought. Researchers from Baden-Württemberg and their industrial partners are already working on tapping the huge potential of extremophilic bacteria.

Where does the main potential of microbial exotics and their metabolic products lie? How can scientists discover, analyse and put enzyme systems in extremophilic bacteria to good use in numerous applications? This dossier provides insights into this potential and into possible applications to which it could be applied.

Publications:

Cypionka, H. (2010). *Fundamentals of Microbiology.* Springer Berlin Heidelberg.

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