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## EXTREMOPHILES AND THEIR BIOTECHNOLOGICAL EMPLOYMENT

*В статті розкривається значення терміну “екстремофіли” та показане їх застосування в біотехнології.*

***Ключові слова:*** *біотехнологія, біооб’єкт, екстремофільні організми, внутрішньоклітинні та мембранні структури.*

*In the article the term “extremophiles” is explained and their biotechnological use is displayed.*

***Key words:*** *biotechnology, bioobject, extremophilic organisms, subcellular and membrane structures.*

Modern biotechnology has great influence on development of medicine, agriculture, ecology and another industry sectors. Nowadays, biotech production has a high demand. However, in the development of biotechnology there is a series of problems associated with the impossibility of cheapening or expanding production capacity. Often, such problems arise in the event of non-compliance of the qualitative properties of the producer (bioobject) with the conditions that are necessary for the course of the process.

These problems can be overcomed with the help of extremophilic organisms that have a number of properties that are not inherent in the classical strains of producers used in biotechnology. These properties include thermal stability, resistance to antibiotics and other substances, acid resistance, and an increased conversion rate.

Extremophiles are organisms that have been discovered on earth that survive in environments that were once thought not to be able to sustain life. These extreme environments include intense heat, highly acidic environments, extreme pressure and extreme cold. Different organisms have developed varying ways of adapting to these environments, but most scientists agree that it is unlikely that life on Earth originated under such extremes. Mechanisms of biochemical adaptation of various microorganisms have many common features: the synthesis of enzymes that exhibit significant resistance to the corresponding extreme factors; compounds that provide the stability of subcellular and membrane structures; change of metabolic pathways and the speed of individual reactions; modification of the composition and structure of the membranes [2].

One type of extremophiles is called thermophiles. These organisms can survive at very high temperatures. In the 1960s, heat resistant bacteria were discovered in hot springs in Yellowstone National Park. This bacteria, thermus aquaticus thrives at temperatures of 70°C but can survive temperatures of 50°C to 80°C. A few years after these were discovered, other bacteria were found living under even more extreme conditions. Hydrothermal vents were discovered deep in the ocean and under such high pressure that the water boils at 340°C. It was a surprise to researchers to discover bacteria living and thriving in the vents at such extreme temperatures and pressures. Not only there were bacteria, but centimeters away where the water was cooler, was a complete ecosystem living off the bacteria. There were clams and tubeworms among other species.

Other extremophiles have developed ways to cope with cold. Deep ocean water is as a fairly constant temperature of 2°C, but because of its salt content, in colder areas, ocean water can reach temperatures as low at -12°C without freezing.

Extremophiles known as psychrophiles are known to survive at these low temperatures. Different species have come up with different ways to survive these cold temperatures. Some have developed substances, such as glycerol or antifreeze proteins which lower the freezing point of water by several degrees.

The main danger to organisms of freezing is the damage caused by ice crystals as water freezes and expands. Some species of  frogs and turtles have proteins which actually facilitate the freezing of body liquids. If the animal's body liquids begin to freeze, a chain reaction is started and all of the body's liquids freeze rapidly. This prevents the formation of ice crystals large enough to do any damage. Many kinds of microorganisms can survive freezing and thawing, as long as the problem of ice crystals is avoided.

There are many organisms on the ocean floor, even at great depths. Life has been found 11 km deep in the Mariana Trench. At this depth, organisms are under a pressure of 1,100 atmospheres. These organisms are difficult to study because creating such a high pressure environment in a laboratory is extremely challenging [1].

This way, extremophilic organisms are able to solve the following problems: obtaining thermostable enzymes for different purposes, reduce the number of phases in the biotechnological process, simplify the conditions that need to be created to ensure the flow of the process, increase the yield of the product [3].

Until recently, researchers had problems with the cultivation of "wild" extremophiles and their use. The problem of cultivating extremophiles is quite low productivity. The solution to this problem was the cloning of the necessary genes in various mesophilic systems (for example, cloning and expression of thermostatic xylanase from Rhodothermus marinus in E.coli; pululanases from Desulfurococcus mucosus in Bacillus subtilis.). Also, new cultivation methods have been introduced. The use of dialysis bioreactor allowed the yield of Sulfolobus shibatae biomass to be 30-40 times higher than that of a conventional fermentor, due to the removal of secondary metabolites - synthesis inhibitors [2].

The most promising for industrial use are enzymes of thermophiles. When applied, the risk of microbial contamination decreases, the solubility of substrates increases and the viscosity of the culture fluid decreases. Most thermophilic enzymes have high thermostability and optimum pH at a temperature of 70 to 125 °C. Thermophilic and hyperthermophilic microorganisms are the source of highly thermostable hydrolases used in various industries. Psychrophilic microorganisms can also be used as producers of hydrolases for the food industry and industrial wastewater treatment. Alkalophylic microorganisms are a source of enzymes resistant to temperature at alkaline pH values. They are used in cosmetology (elastase and keratinase), in the production of detergents (proteinases, cellulases, amylase, lipase). Enzymes of the nucleic exchange (DNA polymerase, ligase, restriction enzymes, phosphatase) are used in molecular biology and medicine [2].

The variety of adaptations organisms make - to extreme temperatures and other extremes such as very acidic or very alkaline conditions - are very diverse. Biologically it is typically easier for organisms to adapt to chemical extremes than to physical extremes like temperature and high pressure. But life can exist in the most unsuitable places for it and extremophiles prove it. We can use such abilities of different strains for biotechnology needs. Modern biotechnologists should continue to research extremophylic organisms for its active use in the future.

**Література:**


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