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Extremozymes from deep-sea extremophilic microorganisms

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The deep-sea is one of the largest biomes on earth. It is known to be an extreme environment as it has extreme temperature, pressure, salinity, pH, chemicals, etc. Some microorganisms have adapted to this harsh environment, and survive and thrive in the deep sea. They have developed unique mechanisms and molecular means to cope up with the adverse conditions. Enzymes derived from such microorganisms are known as extremozymes. They exhibit properties such as extreme thermal adaptability, salt and pressure tolerance, a wider pH range, etc. Depending on the property they exhibit, the enzymes are categorised as thermophilic, psychrophilic, halophilic, and piezophilic. Industrial processes require biocatalysts that can remain stable and carry out reactions in sub-optimal conditions and extremozymes can execute this. A major concern during industrial fermentation is the increase in temperature that is not suitable for mesophilic bacteria. Due to this enzymes obtained from thermophiles have gained a lot of importance. Thermostable amylolytic enzymes are ideal for industrial processes as they can degrade starch at high temperatures reducing the risk of contamination significantly. Thermococcus sp. is an alpha-amylase producer obtained from a deep-sea hydrothermal vent. The enzyme derived from this bacterium is capable of operating at temperatures above 110°C and a pH of 4.0 – 6.5 making it suitable for use in biofuel and ethanol production. Flammeovirga pacifica and Geobacillus sp. also produce thermostable alpha-amylase.
Cold-adapted enzymes can be beneficial in food industries to avoid spoilage. They can also be useful in molecular biology to allow experiments to be performed at lower temperatures. Xylanase producers, such as Zunongwangia profunda and Flammeovirga pacifica have potential applications in the food industry as an additive to wheat flour to improve dough handling and the quality of the baked products. Most of these extremophiles exhibit multiple adaptations that make them even more useful. Zunongwangia profunda isolated from deep-sea sediments can also produce cold-stable and salt-tolerant alpha-amylase. It is one of the few alpha-amylases that can tolerate both extreme cold and extreme salinity. This may be particularly useful for treating wastewater that is high in salt and starch concentration. A thermostable and alkali-stable keratinase obtained from a deep-sea Bacillus sp. can be used as a detergent additive as they withstand 40-60°C temperature and pH 9.0-11. Several such microorganisms have been isolated from various marine habitats. Industries such as agricultural, pharmaceutical, food processing, chemical, and biotechnological sectors can benefit from the use of these extremophile-derived enzymes. Extremozymes represent the basis for the development of environment-friendly and efficient industrial technologies.

Keywords: Extremozymes, Deep-sea, Microorganisms, Biocatalysts

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