

# Psychrohalozymes from Extreme Environments: A Culture-Dependent and Metagenomic Approach for Sustainable Bioprocessing

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## ABSTRACT

Bioindustries increasingly seek enzymes and biomolecules that function efficiently in low-temperature and high-salinity environments, where conventional enzymes often show reduced stability and activity. Psychrohalozymes, enzymes adapted to cold and salt, demonstrate remarkable catalytic performance under these extreme conditions and hold great potential for applications in pharmaceuticals, bioremediation, food processing, and biofuel production. These enzymes can enhance process efficiency, reduce production costs, and increase the commercial viability of products. Psychrohalozymes can improve process effectiveness, lower production costs, and increase the commercial viability of products. The cold and hypersaline ecosystems in the Ladakh region of India provide a unique habitat for psychrohalophilic microorganisms, offering a rich source of novel biocatalysts for industrial innovation. We isolated 111 extremophiles from Ladakh region using culture-dependent methods, and these strains produced enzymes such as proteases, amylases, cellulases, and xylanases under varying saline conditions (3%-15%). Metagenomic analysis with the Illumina NovaSeq X platform revealed novel genes and biomolecules with significant biotechnological potential, expanding the known diversity of extremophiles. This dual approach to discovering novel enzymes and biomolecules paves the way for a more sustainable future by highlighting the potential of extremophiles and their enzymes in industrial processes and the production of sustainable bioresources. Our research underscores the untapped potential of extremophiles to address global industrial challenges and advance sustainable biotechnological solutions.

**Keywords:** Extremophiles, Psychrophiles, Halophiles, Psychrohalozymes, Extremophiles.

## How to Cite

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