

The Role of Stress-Resistant *Pseudomonas* Strains

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Abstract

Stress-resistant *Pseudomonas* strains have attracted considerable attention because of their ability to survive and function under diverse environmental and physiological stresses. These bacteria are widely distributed in soil, water, plant-associated environments, and other ecological niches, where they demonstrate remarkable metabolic versatility and adaptability. This study examines the role of stress-resistant *Pseudomonas* strains in environmental sustainability, agriculture, and biotechnological applications. Particular emphasis is placed on their tolerance to abiotic stresses such as salinity, drought, temperature fluctuations, heavy metals, and chemical pollutants. Stress-adapted strains may contribute to plant growth promotion through mechanisms including phosphate solubilization, production of phytohormones, siderophore synthesis, and biological suppression of certain plant pathogens. Their metabolic capabilities also make them potentially valuable for the biodegradation and bioremediation of environmental contaminants. The study further explores the physiological and molecular mechanisms underlying stress resistance, including antioxidant responses, biofilm formation, membrane adaptation, production of protective metabolites, and regulation of stress-responsive genes. These characteristics may enable selected strains to remain active in challenging environments where conventional microbial applications are less effective. However, successful utilization requires careful strain identification, assessment of ecological safety, consistency of performance, and evaluation under field conditions. The study concludes that stress-resistant *Pseudomonas* strains represent a promising biological resource for sustainable agriculture, environmental remediation, and industrial biotechnology. Further genomic, physiological, and field-based research is necessary to understand their adaptive mechanisms and develop safe and effective applications.

Keywords: *Pseudomonas*, Stress Resistance, Stress-Tolerant Bacteria, Plant Growth Promotion, Bioremediation, Biofilm Formation, Abiotic Stress, Agricultural Biotechnology, Environmental Sustainability, Microbial Adaptation, Biocontrol, Biotechnology.

