


Chapter 13

Application of Extremophiles in Medicine and Pharmaceutical Industries

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ABSTRACT

Extremophiles are at center stage of scientific interest owing to their peculiar properties in terms of physiology, ecology, biochemistry, and molecular genetics. The bio-active compounds from extremophiles involve various types of extremolytes. The functional applicability of extremophiles has been far-reaching. Looking to the global scenario medical, pharmaceutical and allied healthcare sectors have a persistent surge for a novel anticancer, antimicrobial, stable drug deliverables, nutraceuticals, fine chemicals, natural antioxidants, and bio-polymers compounds. Genetic engineering tools clubbed with -omics approach enhance and better the chances for applicability of the extremophilic metabolites in varied sectors of red and yellow biotechnology. The chapter provides an insight into the various types of bio-active molecules from extremophiles and their wide biotechnological applicability in the medical and pharmaceutical industry.

INTRODUCTION

DOI: 10.4018/978-1-7998-9144-4.ch013

Application of Extremophiles in Medicine and Pharmaceutical Industries

Ocean embraces about 80% of the minuscule life forms that are highly diverse and less estimated, yet have been a major area of interest (Kateb G., 2021). Marine waters have an enormous quantity as well as a range of assorted compounds/metabolites derived from the biological origin and found to contribute to human welfare. The marine bioactive compounds are explored for copious biotechnological uses (Rathinam & Sani, 2018). Additionally, they have astonishing peculiarities in terms of the synthesis of various bioactive compounds and/or antimicrobial substances (Olaniyan & Adetunji, 2021) that may serve as a model for futuristic biotechnological applications.

Microorganisms that are capable to alter their cellular mechanism in response to surrounding extremities are regarded as extremophiles. They are the remarkable ones that endure in extreme surroundings such as high salinity, temperature, pH, osmotic pressure, ion concentration, and radiation (Hagagy et al., 2021). The extremophiles possess more than one adaptability property due to which they are utmost explored and are also referred to as polyextremophiles (Raval et al., 2013; Raval et al., 2015; Di Donato et al., 2018; Patel, 2020). The “survival strategies” adopted by extremophiles also show a profound effect on their potential applications (Daoud & Ali, 2020). Extremophiles have become a focus of scientific interest owing to their peculiar properties in terms of physiology, ecology, biochemistry, and molecular genetics. Furthermore, the potentiality of bioactive compounds from unexplored and immense surroundings that gain key interest amongst the scientific community nowadays (Kushveer et al., 2021; Patel et al., 2021). They possess distinct adaptation mechanisms that make them fascinating to explore the properties of bioactive compounds from extremophiles (Baria et al., 2020). The chapter is shaped in a way to give insights into types of bioactive molecules from extremophiles and their comprehensive biotechnological applicability in the medicinal and pharmaceutical industry.

DIVERSITY AND ECO-PHYSIOLOGICAL ADAPTATIONS OF EXTREMOPHILES

Extremophiles are diverse microorganisms and endure extremities, show peculiarities for persistence and progression. The acquaintance of bioactive molecules, enzymes and novel compounds from extremophiles exemplify and render enhanced attention (Patel et al., 2021). However, the higher life forms are unable to withstand extremities when compared with the bacterial and archaeal counterparts. Concerning eco-physiological adaptations, extremophilic microbes are well classified via extreme ambiances and the geophysical constraints viz. temperature, pH, salinity, ionizing radiation, and osmotic pressure. Based upon peculiarities, robustness, and diversity many adaptation strategies has been employed by extremophiles viz. high salt-in, salting-out, compatible solute synthesis, sodium pump, chloride pump, osmoregulation, pH, etc. (Amoozegar et al., 2019).

Eco-Physiological Adaptation of Extremophiles

Temperature

Temperature theatres an imperative role in the growth of extremophiles. Any trivial change can affect the diversity and type of microbial system residing therein drastically. The extremophiles that acclimatize their cellular machinery in response to wavering temperature are regarded as thermophiles (Joyce, 2021). Generally, they are adapted to endure in surrounding 15°C & above 85°C are referred to as thermophiles.

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