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The Use of *Streptomyces coelicolor* in the Removal of Heavy Metals

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Abstract

In recent years, in order to improve the standard of living of human being, outstanding studies have increased on microbial technology. This article focuses on the interactions between secondary metabolites of Streptomyces and heavy metals, as they have been presented in literature stemming from two different studies: The removal of heavy metal and the role of heavy metal on secondary metabolites of Streptomyces and how these interactions fit into accepted paradigms of response to heavy metal, resistance mechanisms and production of secondary metabolites.

Keywords: *Streptomyces coelicolor;* Removal of heavy metal; Secondary metabolites

Introduction

Organisms known as actinomycetes are the richest source of special metabolites. They are conventionally used to describe filamentous, Gram positive actinobacterium existing in soil, including those of the most prolific genus Streptomyces. This genus is home to the best known strain A3 (2) of *Streptomyces coelicolor* which is the genetically best-defined streptomycete [1,2].

Streptomyces coelicolor are used as a model representative of a group of soil-dwelling organisms to understand microbial life in the highly competitive soil environment. It is known that bacteria which produce antibiotics can compete with other organisms for nutrient. These actinobacteria are notable for their production of over most compounds that are pharmaceutically important agents such as natural antibiotics, anti-tumour agents and immunosuppressant. These bacteria have over 20 cluster genes coding for known or predicted secondary metabolites and many pigments. However they have many adaptation strategies and capability in producing spores that can live in even dry and hot in soil [1,3,4].

New developing technologies based on microorganisms contribute to human health, by helping removal of different contaminant from the environment. Kothe et al. [4] have expressed that due to *Streptomyces coelicolor* active secondary metabolism producing some antibiotics and pigments; they could be a good source for the identification of some heavy metal binding components by possibly using biotechnological application [2].

Binding of heavy metals to Streptomyces

Although *Streptomyces coelicolor* A3(2) was found to be sensitive to high concentrations of heavy metals, [5,6] they proved to be tolerate higher concentrations and the findings have highlighted a new biologically relevant aspect of the chemical property of vancomycin as a zinc chelator in vitro. Because of some Streptomyces strains showed high resistance to some heavy metal such as nickel and zinc, they have been presumed to contribute a large heavy metal binding capacity [7-9].

In our previous study, we have demonstrated the removal of nickel and copper ions effectively from aqueous solution by using dried *Streptomyces coelicolor* A3 (2) [10]. Our results were essential in determining pharmaceutical disposals for bio-remediation and waste water treatment. Effective removal of heavy metals from wastewaters and industrial wastes still remains a major topic in nowadays research and various ways are there to cope with heavy metals discharged from industrial wastewaters to both water and soil inhibiting microorganisms. However, physiological and biochemical studies in different Streptomyces strains have shown that resistance to heavy metals is produced by several mechanisms, acting either alone or in conjunction: an increased reductase activity; production of extracellular quelators; metal efflux pumps; intracellular sequestration and bio-mineralization [11]. Although heavy metals are known to be toxic; metals such as nickel, cobalt, copper, manganese, and others are considered essential micronutrients needed as cofactors in many enzymes [12] and nickel was reported to be necessary for the reactive center in urease and superoxide dismutase of streptomycetes [13].

Actinorhodin production *by Streptomyces coelicolor* A3 (2), and the effects of metals on the growth and antibiotic synthesis has been studied [14-16]. Abbas and Edwards [17] have reported that the reduction in the antibiotic production was observed when some metals were added during the antibiotic-producing phase and little reduction of final actinorhodin titers was observed [17]. However, due to the specific adaptation strategies of some streptomycete strains, they can cope with high heavy metal concentrations [5,18]. Melanin-like pigment produced by some Streptomyces during growth in nickel containing media was reported to bind to metal and the capacity of this pigment to form nickel complexes was determined [3,19]. Similarly actinorhodin-related blue pigments produced by *Streptomyces coelicolor* A3 (2) can be used to form new complexes with heavy metals [4,20] that might be very convenient in the removal of heavy metals. The biomasses of Streptomyces species were reported to be capable of biosorption of heavy metals [21]. Schütze and Kothe [11] have mentioned that several morphological, physiological and reproductive characteristics coding on major genome of Streptomyces would allow its species to occupy extreme environments or contaminated environment [11]. Since these properties are shared by all species of the genus, it can be interpreted as an evidence for the inheritance of resistance to heavy metals.

Conclusion

Streptomyces species have got tolerance to variety of heavy metals.

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Therefore, Streptomyces that are waste products obtained from pharmaceutical manufacturers are vital in improving environmental biotechnology; however bioaccumulation studies of heavy metals and biosorption studies with most heavy metals in *Streptomyces coelicolor* were not studied to date. Bioaccumulation and biosorption studies combined with genomic, biochemical and physiological information will be indispensable for efficient wastewater treatment in future.

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