

Review on Melanin from Marine Actinomycetes

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Abstract: Marine microorganisms have become an important source of pharmacologically active metabolites. It is an important part of the natural products which includes secondary metabolites, antimicrobial, antitumor, antioxidant and antiviral compounds. For the past few decades, marine organisms have been the focus of a worldwide effort for the discovery of novel natural products. Actinomycetes from the marine environment one of the novel bioactive producer. The brown-black pigment has been referred to as 'melanin' and as 'melanin like' pigment. It has been shown to protect micro-organisms against U-V radiation, enzymatic lysis, oxidants and killing by alveolar macrophages. Melanin has an immense biotechnological application, but understanding the importance and novelty of melanin from marine actinomycete is very little. At this juncture, this review briefly describing the importance melanin from marine actinomycetes.

Keywords: Marine, actinomycetes, melanin, antibacterial, antioxidant.

INTRODUCTION

Actinomycetes are biotechnologically important microorganism and they produce many pigments with industrial applications. Marine environment is an interesting research area with multitudinous promising pharmaceutically important compounds [1]. Actinomycetes from the marine environment have been shown to be highly productive and secrete interesting compounds compare to terrestrial counterparts. Marine actinomycetes not only exist in the water and sediment of oceans, but they are also widely associated with in different marine ecosystems like estuarine habitats, sea grasses, fishes, Phyto plankton, salt marsh plants, sponges, sea urchins, mangrove, coral reefs etc., The exploitation of marine actinomycetes as a source of novel secondary metabolites is in its infancy. Actinomycetes, one among the most colourful microbes are characterized by the production of various pigments on different natural and synthetic media. The pigment production from microbes has advantages because they can produce pigments on an economically feasible medium and they have fast growth. It is an emerging field of research which has various industrial applications [2].

NATURE OF MELANIN

Microbial pigments are varied in colours like bright carotenoids, prodigiosin, quinones, violaceins, and phenazines to the dark pigment melanin. Melanin are enigmatic pigments and biological macromolecules that

are produced by a wide variety of microorganisms including several species of bacteria, actinomycetes and fungi. In humans and most of the mammals has eumelanin and pheomelanin in their skin. Skin pigmentation has been a subject of interest since ancient times. Un till the year 1819 that pigment cells, called chromatophores, were described in studies with the squid. Later, similar structures were recognized in human skin and eyes. The term melanin was for the first coined by C. P. Robin in 1873 and later research the specialized cells responsible for melanin synthesis in the skin, the melanocytes, were identified [3].

Melanin can be extracted from plant and animal tissues, or generated by chemical synthesis. However, these processes are relatively expensive and not a eco-friendly approach [4]. Microbial mediated production is the best viable alternative to obtain melanin. This method has the advantage of being scalable and providing a good yield of melanin.

BIOSYNTHESIS OF MELANIN

The enzyme tyrosinase catalyzes the hydroxylation of L-tyrosine to L-DOPA using molecular oxygen and then oxidizes this compound to dopachrome, which nonenzymatically polymerizes to yield melanin [5]. Based on their amino acid sequence and functional features, microbial tyrosinases can be divided into five main groups [6]. The tyrosinase from *Streptomyces* sp. is included in one of these groups. They have in common the requirement of a chaperone protein that inserts copper atoms into the active site of the tyrosinase.

Pigment production, an important property of the actinomycetes Some of the bioactive pigmented

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compounds investigated from marine actinomycetes includes melanin, prodigiosin, carotenoids and quinones etc., These are widely used in many industries such as textiles, food, painting, cosmetic and pharmaceuticals [7]. Melanin is not an essential for the organisms' growth and development, but they play an important role in improving their survival and competitiveness. Melanin are polymers with diverse molecular structures that typically appear black or brown formed by the oxidative polymerization of phenolic and indolic compounds. It is negatively charged, hydrophobic; insoluble in aqueous or organic solvents, resistant to concentrated acid and susceptible to bleaching by oxidizing agents [8,9] But, the application of melanin from marine actinomycetes poorly studied. So, this review focused on this.

APPLICATION OF MELANIN

Melanin compounds have broad spectrum of potentiality including antioxidant, antimicrobial activity, antitumor, antivenin activity, anti-virus, hepatoprotective activity and radio protective etc. Effectively, it protects the living organisms from extreme temperature and ultraviolet radiation [10]. Melanin is used as an additive in sun screen lotions and creams because of their immense UV absorptive and radical scavenging properties. It containing cosmetic property that protect the cells from high energy blue/violet visible light that may minimize the premature ageing [11].

All *Streptomyces* strains are reported to use tyrosinases in the synthesis of melanin pigments [12]. Diffusible dark pigment producing *Streptomyces* sp was isolated from sediments of Vellar estuary, Tamil Nadu using starch casein agar. The dark pigment was identified as melanin by Fourier transform infra-red spectroscopy and suspected the pigment as eumelanin type. Crude extract of melanin has antibacterial activity against *Escherichia coli* (20 mm) and *Lactobacillus vulgaris* (2 mm) [13]. Another study the dihydroxy phenylalanine (DOPA) melanin compound was biochemically identified and spectroscopically characterized from *Streptomyces* sp., MVCS6. This DOPA melanin showed activity against pathogenic bacteria against *Pseudomonas aeruginosa* RMMH7 (inhibition zone of 18 ± 0.02 at 30 $\mu\text{g}/\text{disc}$, and MIC of 10 ± 0.02 $\mu\text{g}/\text{mL}$) and *Vibrio parahaemolyticus* RMMH12 (inhibition zone of $15 \text{ mm} \pm 0.03$ at 30 $\mu\text{g}/\text{disc}$, and MIC of 14 ± 0.02 $\mu\text{g}/\text{mL}$). Cytotoxicity of DOPA melanin

against cervical cancer cell line showed a dose-response activity, and IC_{50} value was found to be 300 $\mu\text{g}/\text{mL}$. These results may open a new strategy to a promising bioactive eumelanin with therapeutic potential [14]. Manivasagan *et al.* [15] isolated melanin from marine actinobacteria, *Actinoalloteichus* sp. MA-32. It has antibacterial and antioxidant activity. They observed antioxidant potential of melanin. Melanin and its derivatives are used as therapeutic agents to cure retinitis pigmentosa, neurodegenerative diseases like Alzheimer's disease, schizophrenia and dementia [16]. Marine *Streptomyces cavourensis* strain RD8, also produced melanin, showed high antioxidant and antibacterial activity [17].

The occurrence of melanin production by rare actinomycetes is much lesser when compared to *Streptomyces* spp. But surprisingly, two melanogenic marine actinomycetes namely *Nocardopsis dassonvillei* and *Nocardopsis* sp. exhibiting melanin production which was isolated from marine soil sediment samples of the Allepey Beach, Alappuzha, Kerala, India. In this study, the melanin pigments exhibit antibiofilm activity with the highest of 64.20% and 65.99% respectively against *Staphylococcus* sp. They also showed antibacterial activities against human pathogens with the highest activity of 61.28 ± 0.280 % and 68.08 ± 0.141 % against *Listeria monocytogenes* and *Bacillus* sp respectively at 150 $\mu\text{g}/\text{mL}$. It was also observed that melanin as a potential anti-quorum sensing agent as there was a significant reduction in the proliferation of the indicator organism, *Chromobacterium violaceum* MTCC 2656 [18].

Melanin producing *Streptomyces* sp. BI 244 was isolated from sediment of Coromandel Coast region of the Bay of Bengal, Tamil Nadu, India. Extracted melanin showed antimicrobial efficacy against *Staphylococcus aureus* (17 ± 0.3 mm) *Enterococcus faecalis* (16 ± 0.041) and *B. subtilis* (13 ± 0.2), moderate activity towards *E. coli* (10 ± 0.3) *K. pneumoniae* (7 ± 0.1), *S. typhi* (10 ± 0.1), *Shigella* sp. (9 ± 0.4) and *C. albicans* (10 ± 0.2). Melanin from *Streptomyces* sp. BI 244 has potent cytotoxicity on HeLa cells on time and dose dependent manner and antioxidant activity. This results clearly indicated that melanin will be used as antioxidants as a replacement of conventional synthetic antioxidants in food and food [19].

Ramesh *et al.* [20] extracted melanin pigment from marine *Streptomyces* sp. This strain was isolated from

soil samples of Andaman Islands and proved for its antibacterial potential. Diverse species of *Streptomyces* produce melanin and the production of the pigment is used in the taxonomical identification of the genus [21]. Specifically, melanin production is well described in *Streptomyces antibioticus* [22, 23] and *Streptomyces glaucescens* [24]. Amal *et al.* [10] selected the Melanin pigment for printing and dyeing of wool fabrics, which was extracted from *S. virginiae*. Thus, this results indicated the melanin pigment is a suitable eco-friendly dye for dyeing and printing of wool fabrics as a replacement of synthetic dyes.

CONCLUSION

Marine ecosystem is a potential source of novel metabolites. By considering the present scenario many unexplored bioactive molecules may present in marine actinomycetes. Particularly, melanin has an antibacterial, antifungal, antioxidant activity and also it can be used for industrial biotechnological application because microbial melanin can be produced in large scale with low production cost. In this context, we hope that this review will be useful and will encourage researches on melanin, especially from marine actinomycetes.

CONFLICTS OF INTEREST

There is no conflict of interest.

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