



Biosynthesized Nanoparticles for the Dermaceutical Applications: A Review

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Abstract

The emergence and advancement of nanotechnology have brought nanomaterials into close proximity with human life through applications such as water remediation, diagnostics, therapy, skin protection, catalysis, electronics, and more. Over the past two decades, researchers have extensively explored and commercialized the biomedical applications of nanoparticles. The amalgamation of nanotechnology with dermaceuticals has significantly improved the quality and effectiveness of cosmetic products. Their use in cosmetic products has improved efficacy by increasing penetration efficiency, enhancing UV protection ability, prolonging the effect, and improving appearance and fineness. Among several types of nanomaterials, biosynthesized ones have shown promising potential in cosmetic applications, and they can be used as UV blockers, anti-aging and moisturizing agents, anti-inflammatories, antioxidants, anticancer agents, and wound-healing materials in skin care products. Additionally, biomaterials provide an ancillary effect to nanomaterials, increasing the performance of cosmetic ingredients. The present review provides information on various nanomaterials synthesized using different biomaterials and their role in skin care applications. This review also discusses the economic viability and potential toxicity of nanoparticle-based cosmetic products. Finally, we address the challenges associated with biosynthesized nanomaterials in cosmetic and skin care products.

Keywords Biosynthesis · Biomaterials · Nanoparticles · Dermaceutical · Skin protection · Toxicity

1 Introduction

Cosmetics, which have been used since ancient times, are one of the most important aspects of the current generation. Various cosmetic products, from hair colors to nail polish, have been used by women and men to enhance appearance and beauty. The fusion of cosmetics and pharmaceuticals has led to the foundation of dermaceuticals, involving research-based skincare solutions for various dermatological issues like anti-ageing, sunscreen, and moisturizing lotions. Dermaceuticals are made with powerful ingredients like peptides, antioxidants, growth factors, and plant extracts. These products do more than just improve appearance—they help

keep the skin healthy. As more people look for skincare that truly works, dermaceuticals are changing the industry and turning skincare into both a science and an art. The demand for skincare products is rising in tandem with the population, contributing to a fast-growing industrial economy having a revenue of 100.49bn USD worldwide [1].

With growing awareness, consumers now demand safe, nontoxic cosmetic products. In response, companies are replacing harmful chemicals with natural, herbal ingredients having medicinal properties. Presently, consumers seek clean, affordable, and effective products, driving innovations in cosmetic manufacturing toward safer and more sustainable formulations. The introduction of nanotechnology has begun to revolutionize the biomedical field by modifying conventional concepts and adapting newer technologies for biomedical applications. Nanotechnology implies the use of nanoparticles having sizes ranging from 1 to 100 nm exhibiting unique physical, chemical, and biological properties [2, 3]. The high surface-to-volume ratio, adjustable optical and electric properties, and tunable surface and morphological properties have made nanoparticles applicable in a wide range of fields like drug delivery [4], diagnostics [5, 6], therapeutics [7, 8], health

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