Silver Nanoparticles In Cosmetics: a New Challenge Using Marine Resources

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Abstract. Numerous developments in the medical profession are attributable to nanotechnology. Due to their promising action, nanoparticles have always been the main focus when it comes to silver and its biological synthesis. These nanoparticles' primary field of use is medicine, where studies have examined how these particles' size and shape affect bacteria, fungus, and other species. Using AgNPs as chemopreventive agents in sunscreen creams is one way to employ them. It is crucial to develop novel materials to shield the skin from ultraviolet (UV) radiation and preserve the body's largest and most extensive organ, the skin's homeostasis. To ensure maximal sun protection, it is crucial to utilize skin care products with active sun chemopreventive ingredients

1 Introduction

AgNPs, or silver nanoparticles, have been the subject of extensive research due to their excellent biological, chemical, and physical characteristics. In order to minimize dangers to individuals and the environment while optimizing the potential applications of AgNPs in many fields, a thorough understanding of their features is required. Generally speaking, physics, chemistry, and biology can be used to create AgNPs. Furthermore, there is potential to investigate AgNPs for a range of applications. Future difficulties with AgNP synthesis, environmental release, and expanded production point to a number of possible areas that could be explored to make these nanoparticles safer and more effective. AgNPs are being studied more because they have been shown to work in a variety of applications [1].

Green synthesis techniques can be used to develop methods for the synthesis of silver nanoparticles. Green synthesis is a method of producing AgNPs that makes use of natural materials as bioreductants [2]. The benefit of green synthesis is that it is environmentally friendly, the method is simple, and the toxicity of the material formed is minimized[3]. The primary properties of nanoparticles are those that are used in a variety of applications. When compared to the bulk material, the properties of these nanoparticles are very different [4]. The benefits of these properties are used in a variety of fields. Figure 1 depicts the distinct properties of nanoparticles.

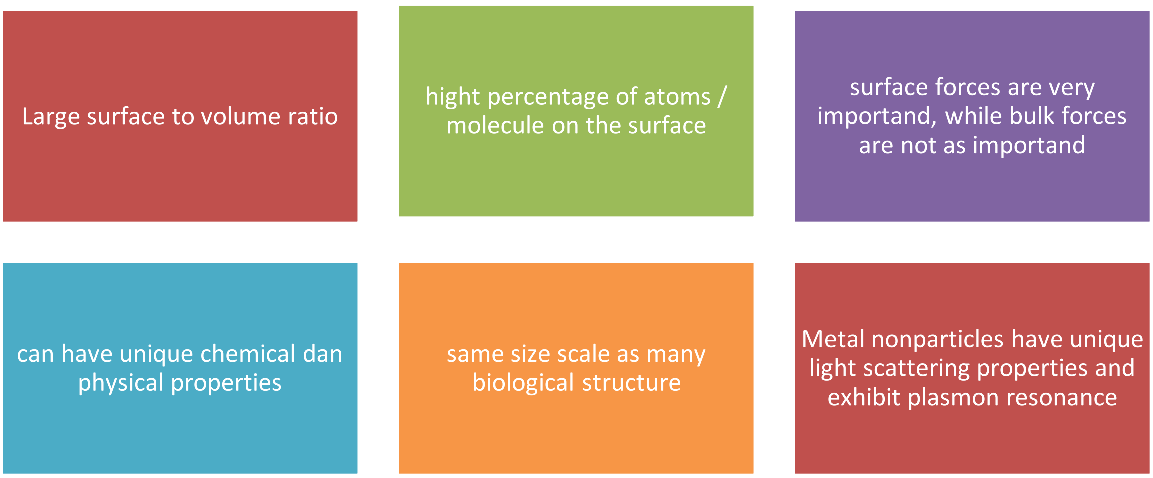

Figure 1. Main properties of nanoparticles

Several natural sources, including those derived from marine sources, have been widely reported in the production of nanoparticles. Because of the promising potential in this sector, marine plant sources have been extensively researched to date. The biomedical properties of marine plants are an important consideration in the development of applications to aid in the synthesis of metal nanoparticles. The antibacterial properties of red algae were tested using the disk diffusion method. AgNPs inhibited the growth of gram-positive *E. coli,* and *C. albicans,* which is a fungus with no cells [5]. Marine *cyanobacteria,* seagrass, marine bacteria, marine sediment fungi, marine sponges, and mangrove plants were used to create the nanoparticles [6]. In addition to antibacterial properties, marine plants' antioxidant potential is beneficial in a variety of fields.

Sonneratia Alba (SA) is a common mangrove plant found along the coast of the Riau Islands. The plant has long been used for its antibacterial, antioxidant, and anti-cancer properties, which have been extensively researched [7,8]. The challenge of synthesizing metal nanoparticles using natural reducing agents is one that could be pursued further [9]. The challenge of synthesizing metal nanoparticles using natural reducing agents is one that could be pursued further.

Plant-derived natural materials are known to be capable of reducing metal ions such as silver ions (Ag^+) to Ag because plants contain chemical components that can penetrate metals [2]. Marine plants are one source of plant compounds that can be used as bioreductants. The role of nanotechnology in conjunction with natural materials is currently underutilized. Because of the rapid advancement of nanoparticle technology, these nanoparticles are becoming increasingly common in the pharmaceutical industry, particularly in cosmetics. The goal of this review is to describe marine natural materials that have the potential to be green synthetics for the use of nanosilver in cosmetics.

2 Research Objectives and Methodology

2.1 *The research methodology*

which consists of a literature review, was designed to achieve three goals. (1). (2) Develop a thorough understanding of green synthesis using natural materials. (3) Explain the role of nanoparticles in cosmetics.Silver nanoparticles used in cosmetics

2.2 *Literature Review*

2.2.1 *Marine reductor as green syntesis*

Green synthesis is an important field of nanotechnology in which nanoparticles are produced using biological organisms such as microorganisms, plant extracts, or plant biomass and can be used to replace environmentally friendly chemical and physical methods. Green synthesis is preferred over physical and chemical approaches because it is more environmentally friendly, cost-effective, large-scale synthesis is easily scaled, and no high temperatures, energy, or toxic chemicals are required. Plant extracts may be more beneficial than microorganisms because of their ease of repair, lower biohazard, and method of maintaining cell culture, which microorganism processes require.

A variety of mangrove plants have recently been investigated for the synthesis of nanoparticles. Alkaloids, phenols, terpenoids, flavones, steroids, and polysaccharides have been identified as the phytochemicals responsible for its activity. Biotechnology is still being developed for the use of mangrove resources. However, research into the biosynthesis of nanoparticles from mangroves and mangrove associations is scarce. Acanthus ilicifolius, Avicennia marina, Avicennia officinalis, Excoecaria agallocha, Rhizophora apiculata, Rhizophora mucranata, and Rhizophora lamarckii are some mangrove plants that have been studied for NP synthesis. Mangrove-mediated NPs have been reported to have a variety of therapeutic applications depending on their secondary metabolites. This focuses primarily on antimicrobial, antioxidant, anti-inflammatory, anti-diabetic, and larvicidal activity. [10–16]

Biological materials derived from marine materials have the potential to significantly aid in the production of nanoparticles. The role of marine extracts as bioreductants in green synthesis has received a lot of attention. Padina pavonia, a brown algae, was used to create nanoparticles. The results clearly show that the algal extract can be used as a capping and reducing agent in the synthesis of AgNPs. P. pavonia's silver nanoparticles were quite stable, with no visible changes for an extended period of time. All of the analyses used show a wide range of particle sizes and shapes, including pyramids, spheres, polygonals, rods, and hexagonals with very smooth edges. Its dimensions range from 49.58 to 86.37 nm. It can help with biomedical research. [17]

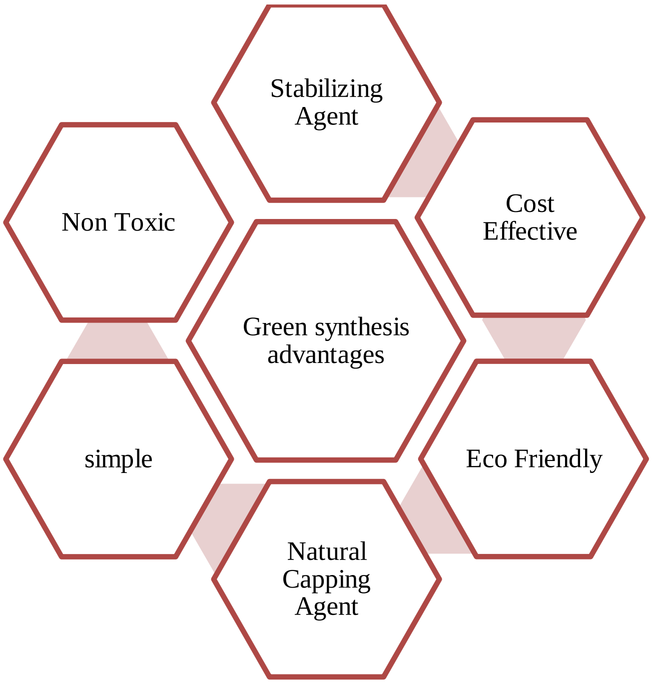

Figure 2. Advantages of synthesizing prak nanoparticles with the green synthesis method

In addition to algae, the use of cyanobacteria in the synthesis of nanoparticles has been developed. The ability of marine actinobacteria to produce nanoparticles of reasonable size and structure with potential applications in biotechnology and pharmacology is gradually becoming known. Mycobacterium sp. BRS2A-AR2 was isolated from the aerial roots of Rhizophora racemosa, a mangrove plant. [18]

In addition to acting as a bioreductant, marine plants have the potential to contain antioxidants in their secondary metabolites. Because of the presence of chromophore groups, which give plants color, flavonoids, one of the most common secondary metabolite components, have the potential to act as sunscreens. The chromophore group is a conjugated aromatic system that absorbs a lot of light in the UV range.[19]

2.2.2 Mechanism of action of silver nanoparticles

Silver nanoparticles have antimicrobial properties, but the exact mechanism is unknown. The binding and penetration of silver nanoparticles by bacteria results in structural changes in cell membranes and cell death. Silver nanoparticles generate free radicals, which lead to cell death as another mechanism of action. The formation of free radicals was revealed by electron spin resonance studies. The interaction of free radicals with bacteria can result in cell membranes becoming porous, leading to cell death. Silver nanoparticles are more effective against microorganisms than other salts due to their large surface area, which allows for better contact with them. The bactericidal activity of nanoparticles in bacterial cells is increased by the release of silver ion [1].

Silver nanoparticles have been tested for their antibacterial properties, particle size plays an important role in their activity, which is influenced by the amount and variation of the concentration of the precursor or pentabilic agent [9]. It is also used as an antimicrobial in cosmetic preparations. Several studies have been conducted to see the effect of nanoparticles as antimicrobial agents or to inhibit microbial growth. The research was conducted using different inorganic materials with various properties. Of these inorganic materials, the most effective in inhibiting bacterial growth is silver nanoparticles (nanosilver) [20,21]. Sunscreen can provide protection against the adverse effects of UVA and UVB radiation.[22]

The abundance of mangrove plants along the coast of Tanjungpinang city, the value of abundant phytochemical content that distinguishes it from land plants. The ability of this compound to act as a bioreductant in the synthesis of silver nanoparticles. The compatible nature of silver nanoparticles has the potential to be realized as an anti-sunscreen cream. The ability of this product not only as a sunscreen, but also as an anti-cancer, antibacterial and antioxidant and anti-inflammatory activity was also tested before being produced into a cream.[23,24]

2.2.3 Silver nanoparticles as cosmetic ingredients

The size of nanoparticles must be taken into account when using nanomaterials. The properties of a material can be influenced by the size of a particle. Color, structural integrity, transparency, optical activity, solubility, and chemical reactivity differ between nanoscale particles and their parent or larger size. Nanoscale materials, for example, have distinct dimensions that enable better solubility by matching the size of cosmetic ingredients to the biological structure of skin cells, resulting in ease of interaction and selectively influencing cellular processes at naturally occurring scales [19]. Cosmetics with nanoparticle properties are able to protect against UV, have a longer lasting effect, have a higher finish quality, and improve skin penetration. *[25,26]*

The skin's structure and composition are altered and oxidative stress is caused by chronic exposure to ultraviolet light from the sun. There are a variety of effects that could occur, from acute changes like erythema, pigmentation, and photosensitivity to long-term effects like premature aging and skin cancer. UV light is a type of sunlight that has a small component of the electromagnetic spectrum and a narrow radiation range, namely 200-400 nm. In the UV spectrum, there are three wavelengths: UV F (290-320 nm), UV G (290-320 nm), and UV A (320-400 nm). The toxic effects of sun exposure can be mitigated by sweating, melanin formation, and horn cell thickening. However, [27–29]

Because synthetic sunscreens are suspected of causing side effects on human skin, many researchers have claimed in recent years that cosmetics containing herbal compound components are safer for hyperallergic skin. This is because natural ingredients are less likely to irritate the skin and are easier to match on the skin. Furthermore, sunscreens containing natural ingredients are gentler on the skin. [26,30–32]. The cosmetics industry was among the first to employ and patent nanotechnology and nanomaterials. Product formulation, packaging, and cosmetic manufacturing equipment are examples of applications. Nanomaterials are used as active carriers and/or formulation supports in cosmetic products to increase product effectiveness. N. Manosalva reported on the evaluation of the use of biogenic-AgNPs as preservatives and sunscreen cream formulations. [20]. Colloidal silver (nano) or (AgNPs) are the most commonly used nanomaterials in cosmetics as chemopreventive agents in sunscreens and as preservative agents in CPs. The Scientific Committee on Consumer Safety (SCCS) considers it a safe preservative. [33] The type of nanomaeryl in cosmetics is seen in the following table:

Table 1. Type nanomaterial in cosmetic

Type materials	Properties		Reference
Inorganic Nanomaterilas	The characteristics of inorganic nanoparticles include being non-toxic, hydrophilic, biocompatible, and highly stable	Ti, Ag, Au. TiO2, For Suncreen as UV Filter	[34]
Carbon Black (Nano) Carbon	cytotoxicity, inflammation.	Eye cosmetics, skin care products, and mascaras often use this cosmetic ingredient as a colorant.	[35]
Silica. SiO2	hydrophilic surface favors prolonged circulation and low production cost	products for hair, skin, lips, face, and nails contain SiO2 for Silica nanoparticles.	[36]
Nano-Organic Materials Tris-Biphenyl	Tris-Biphenyl Triazine is	Ingredient for the formulation of sunscreens	[37]
Silver and Gold Nanoparticles	Used in cosmetics that include deodorants and anti-aging creams. In	Antibacterial and antifungal	[38]

There are several methods for introducing nanoparticles into cells. Skin penetration can occur via three different pathways: intercellular, transcellular, and transapplicable (through follicles and related sebaceous glands and sweat ducts). NPs could potentially be transported through the follicular aperture, which is less than 200 nm. [4]

Table 2. Several research results that utilize nanoparticles as cosmetic

Natural source	Green synthesis	
	Metal nanopartikel	**referensi**
Iris tuberosa as Potential Preservative	Ag	[33]
Aerva lanata	Ag	[39]

Sunscreen can help protect against the harmful effects of UV rays. Sunscreen is a cosmetic preparation used to protect the skin from sun exposure by effectively absorbing sunlight, particularly in the area of ultraviolet wave emission, to prevent sun-related skin disorders [23]. The ability of sunscreen products to absorb ultraviolet light can be calculated by dividing the percentages of erythema transmission (%Te), pigmentation transmission (%Tp), and SPF (Sun Protection Factor) by the percentages of erythema transmission (%Te). Sunscreen preparations can thus be divided into four categories: sunblock, extra protection, suntan, and fast tanning [24]. Marine plant material is thought to have sunscreen potential due to the presence of flavonoids and tannins.[40]

According to research, preservatives in cosmetic formulations serve as a source of nutrition for bacteria, fungi, and yeasts. Cosmetic microbiologists, on the other hand, face a challenge in determining the best type of preservative or preservative system to incorporate into each formula while meeting all toxicological preservation and safety criteria. Preservatives We Use Biogenic AgNPs have a broad antimicrobial spectrum, a known chemical structure, are completely water soluble, compatible with all formulation ingredients, and are inexpensive to produce. As a result, it lends itself well to the cosmetics industry [20].

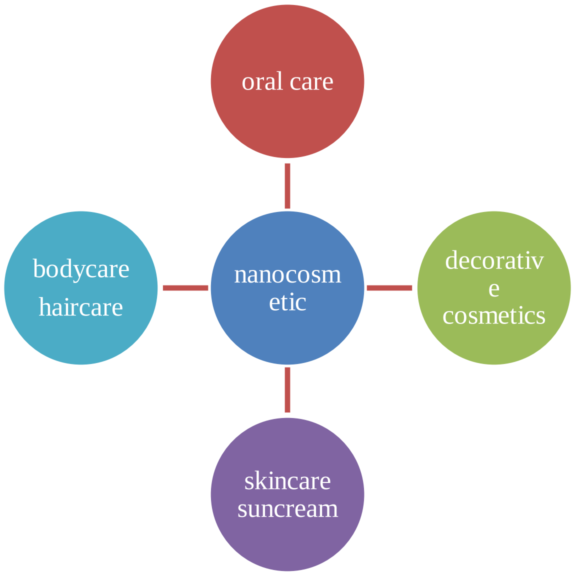

Figure 3. Nanomaterials in various cosmetic applications.

The development of silver nanoparticles as an ingredient in sunscreen cream, based on the antibacterial, anticancer, and antioxidant properties of silver and marine plant bioreductors. High antioxidant capacity; promising as a sunscreen ingredient. The resulting nanoparticles from the marine red algae Acanthophora spicifera demonstrated strong antibacterial, antioxidant, and anticancer properties [25]. Marine algae reported by [26] also showed promising antibacterial effectiveness.[26]. The mangrove plant *Rhizophora stylose* is also reported to have high antioxidant and antibacterial activity which can be widely applied in the biomedical field [8, 50-52].

2.2.4 Characterization tools for analysis of silver nanoparticles

To understand the properties, structure, and components of the target compound, it is necessary to characterize synthesized silver and gold nanoparticles. Furthermore, the development of the resulting application can be comprehended through characterization.

2.2.5 UV-VIS Spectroscopic Analysis

UV-Vis spectrophotometric analysis was used to confirm formation and to track stability. UV-Vis spectroscopy is extremely simple, sensitive, and fast, as well as selective. Silver and gold are characterized using the SPR (Surface Plasmon Resonance) phenomenon, which is the resonance between light waves and electrons on the metal surface that results in quantized electron oscillations on the metal surface. When the photon frequency of a light wave equals the surface's natural frequency. The color change of silver ions to nano silver from colorless to brownish yellow was monitored, and the absorption spectrum and SPR wavelength appeared in the 410-460 range. [41]. This wavelength depends on the particle size [42]. The shape and size have a strong influence on the absorbance value and absorption wavelength. Absorbance is proportional to quantity, whereas wavelength and shift are proportional to size. [43]

2.2.6 XRD(X-ray Difraction)

The degree of crystallinity is provided by XRD, which is commonly used to study crystal structure lines. The crystal structure can be determined by comparing the distance between the diffraction peaks (d) and standard data. XRD analysis can be used to determine lattice dimension, which is the distance between planes in the crystal structure. The diffraction spectrum pattern (diffractiontogram) of each material is unique and describes its properties. The lines of nanoparticle crystal structure are analyzed in nanoparticle synthesis by using XRD characterization to determine the degree of crystallinity. The result is obtained when the distance between the atomic layers in the crystal is represented by variable d and the wavelength of the incoming X-ray file is represented by lambda variable. These observations are examples of the interference of the X-ray wave (Roentgenstrahlinterferenzen), commonly known as the XRD, and are direct evidence for the periodic atomic structure of the crystal that has been observed for centuries.

2.2.7 TEM (Transmission Electron Microscope)

Is a microscopic technique used to provide magnetic information on the morphology, crystal structure, and size of formed NP crystals, as well as the crystalline phase composition and microstructure. Several studies on the ability of other metal nanoparticles to penetrate the skin have been published. In a diffusion cell, the absorption of silver nanoparticles through cut human skin was measured. Silver nanoparticles are coated with poly-vinylpyrrolidone to prevent aggregation. Transmission electron microscopy (TEM) measurements revealed particle sizes ranging from 25 to 48 nm. Aside from very low penetration through the skin, TEM analysis can detect silver nanoparticles in the stratum corneum and viable upper regions of the epidermis.[31, 48-50]

2.2.8 FT-IR

Analyzing the function groups involved in the formation of nanoparticles is done using Fourier transform infrared (FT-IR). A study was conducted on the synthesis of gold and silver nanoparticles. FT-IR analysis is used to find out the functions groups found in bioactive compounds in plant extracts as well as their changes after reaction with precursors in this case silver or gold ions. The spectrum of molecular vibration is considered to be a unique physical property and a characteristic of a molecule. This spectrum can be used as a comparison of unknown spectrum identification paths in the bioactive compound components. This first principle approach is based on the fact that the structural characteristics of a molecule, whether it is the molecular backbone or the functional cluster attached to a molection, produce characteristics and are reproducible.

2.2.9 PSA using Dynamic Light Scattering (DLS)

This characterization principle is based on the principle of measuring Brown Motion and correlating motion with particle size.Observing the sample after shooting with infrared light will produce brown motion. These movements are then analyzed with the device, the smaller the size of the molecule, the faster it moves[46,47]. PSA is used to characterize the silver and gold NP formed to determine particle size, colloid stability, and polydispersity index. The advantage of using this tool is that it has 1% accuracy and reproducibility and can perform measurements in the range of 0.02 nm to 2000nm. Laser rays scatter light at different intensities when the particles in the solution are exposed to them. Light interaction with suspended particles is the basis for this method. DLS can be trusted for particle sizes ranging from 20 to 200 nm. Because measuring the size in the solution the particle moves Brown, the size obtained from the DLS is relatively larger. [41]

3 Conclusion

Nanomaterials can be used in a variety of ways in the cosmetic industry. It is true that as research and development in the cosmetic industry advances and develops, more and more nanostructures are being tested in cosmetics. The goal for the future is simple: find the safest and most appropriate nanomaterials for use in a wide range of cosmetic applications at the lowest possible cost. The green synthesis method for nanoparticle synthesis has numerous advantages. Future projections of major trends and needs in the nanocosmetic field. Nanoparticles have the potential to develop a sustainable and controlled sunscreen cream with increased moisturizing capacity and anti-aging properties. It contains, in addition to the well-known titanium dioxide and zinc oxide, it should continue to be investigated and proposed for cosmetics

Because of their broad range of pharmacological applications, silver nanoparticles are becoming increasingly popular in the cosmetic industry. Silver nanoparticles demonstrate that their antimicrobial and anti-inflammatory properties are the main draw in the development of nanocosmeceutical products. Other applications for silver nanoparticles include antifungal agents in nail paint and pigments in colored beauty products such as lipstick and eye shadow. Although silver nanoparticles are widely used in cosmetics, information on their mechanisms of action and the effects of particles on biofunctions in the body is still scarce. The process of creating silver nanoparticles can occur due to skin penetration and toxicity to the human body, which is influenced by particle morphology and application methods, thus making a significant contribution to extensive research on the relationship between nanotechnology and cosmetics.

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