

Eco-friendly nanosilver sunscreen synthesized using *Kweni (Mangifera odorata Griff.)* leaf extract

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Abstract

Background: Excessive exposure to ultraviolet (UV) radiation can cause premature aging, erythema, and increase the risk of skin cancer. Skin protection can be accomplished by applying sunscreen products. Nanosilver synthesized via green synthesis using *kweni (Mangifera odorata Griff.)* leaf extract has potential as an active sunscreen agent due to its ability to reflect, scatter, and absorb UV radiation, as well as its antioxidant activity.

Objective: this study aims to synthesize eco-friendly silver nanoparticles using *Kweni (Mangifera odorata Griff.)* leaf extract through a green synthesis approach and to evaluate their **Methods:** The sunscreen activity test was conducted using nanosilver synthesized with aqueous *kweni* leaf extract as a bioreductant. The test solution concentrations were 100, 200, and 300 ppm. Measurements were carried out using a spectrophotometer within the wavelength range of 290–320 nm. The SPF value was calculated using the Mansur method.

Results: The SPF values of nanosilver at concentrations of 100, 200, and 300 ppm were 32.98 ± 0.069 , 33.036 ± 0.215 , and 34.037 ± 0.278 , respectively. **Conclusion:** *Kweni* leaf-based nanosilver sunscreen demonstrated high effectiveness with SPF values classified in the *ultra* category. These silver nanoparticles have promising potential for further development as a natural cosmetic product using a green nanotechnology approach.

Keywords: Green synthesis; Nanosilver; *Mangifera odorata Griff.*; Sunscreen activity; SPF value.

Cite This Article

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INTRODUCTION

Excessive exposure to ultraviolet (UV) radiation, particularly UVB (280–320 nm), can lead to oxidative stress, inflammation, premature skin aging, and an increased risk of skin cancer (1–3). To prevent these harmful effects, sunscreen formulations are widely used to protect the skin by absorbing, reflecting, or scattering UV radiation. However, many conventional chemical UV filters, such as oxybenzone and octinoxate, have raised concerns due to potential skin irritation and negative environmental impact(4,5). This has encouraged the exploration of alternative sunscreen agents derived from natural and eco-friendly sources.

Nanotechnology offers promising strategies to enhance sunscreen efficacy by incorporating metal-based nanoparticles. Among them, silver nanoparticles (AgNPs) have gained significant attention due to their strong antioxidant, antimicrobial, and UV-protective properties(6,7). In vitro studies have demonstrated that AgNPs can mitigate UVB-induced oxidative stress in skin cells and improve photoprotection by reducing reactive oxygen species (ROS) production (8,9). The ability of AgNPs to absorb and scatter UV radiation depends on their surface plasmon resonance, which is influenced by particle size, morphology, and synthesis method (10).

Green synthesis of nanoparticles using plant extracts is considered a sustainable and non-toxic alternative to conventional chemical methods (11). Phytochemicals such as phenolics, flavonoids, and terpenoids in plant extracts act as natural reducing and stabilizing agents, facilitating nanoparticle formation(12). Previous studies using *Mangifera indica* leaf extract successfully produced well-dispersed AgNPs with significant antioxidant and antibacterial activities in vitro(13,14). However, there is limited information regarding the biosynthesis of AgNPs using *Mangifera odorata* Griff. leaf extract, which also contains abundant bioactive compounds such as flavonoids and phenolic acids that can potentially serve as natural reducers and stabilizers.

In addition to nanoparticle synthesis, the evaluation of photoprotective potential is essential to determine their suitability as sunscreen agents. The sun protection factor (SPF) can be assessed in vitro using a spectrophotometric method, which measures the absorbance of UV radiation across wavelengths of 290–320 nm (15–18). This method provides a rapid and reliable estimation of the SPF value without requiring animal or human testing. Therefore, this study aims to synthesize eco-friendly silver nanoparticles using *Kweni* (*Mangifera odorata* Griff.) leaf extract through a green synthesis approach and to evaluate their

METHODS

Study design and setting

This research aimed to assess the sunscreen efficacy, expressed as the Sun Protection Factor (SPF), of silver nanoparticles synthesized through an eco-friendly approach utilizing the liquid extract of *Kweni* (*Mangifera odorata* Griff.) leaves as a natural bioreductant and stabilizer. An in vitro experimental design with technical replications was applied to ensure data reliability. The study involved several essential phases, including the preparation of *Kweni* leaf extract, green synthesis of silver nanoparticles, and evaluation of sunscreen activity across different concentrations of the samples. Absorbance readings were obtained using a UV–Vis spectrophotometer within the wavelength range of 290–320 nm, and SPF values were calculated following the Mansur equation. All obtained data were subjected to statistical analysis to evaluate the UV protection potential of the synthesized nanoparticles.

Population, samples and sampling

The population in this experimental research consisted of colloidal silver nanoparticles synthesized via a green synthesis approach using the aqueous extract of Kweni (*Mangifera odorata* Griff.) leaves under controlled laboratory conditions. The test samples were prepared at three concentration levels—100, 200, and 300 ppm—with each concentration analyzed in triplicate to ensure data precision and reproducibility. The selection of these concentration ranges was based on purposive sampling, supported by preliminary findings and previous studies suggesting that higher concentrations of silver nanoparticles tend to improve ultraviolet (UV) protection performance.

Instruments and criteria

The UV–Visible spectrophotometer (e.g., Shimadzu UV-1800, Japan) with a 1 cm quartz cuvette, and Glassware.

Procedure and data collection

A series of nanosilver suspensions with concentrations of 100, 200, and 300 ppm were prepared using ethanol as the dispersion medium. The absorbance of the AgNP samples was recorded using a UV–Visible spectrophotometer (e.g., Shimadzu UV-1800, Japan) across the wavelength range of 290–320 nm to calculate the Sun Protection Factor (SPF) based on the Mansur method. Measurements were conducted using a 1 cm quartz cuvette, with ethanol serving as the solvent blank. Each sample was analyzed in triplicate, and baseline correction was performed prior to each scan to minimize background noise and ensure accuracy of the readings.

$$SPF = CF \sum_{290}^{320} A(\lambda)I(\lambda)EE(\lambda) \quad (1)$$

Statistical analysis

The data will be subjected to descriptive analysis to evaluate the impact of concentration on SPF values.

RESULTS

The SPF test results of AgNP at each concentration are summarized in Table 1.

Table 1. Sun Protection Factor (SPF) values of AgNPs at different concentrations.

Concentration (ppm)	SPF
100	32.98±0.07
200	33.04±0.22
300	34.04±0.28

DISCUSSION

The SPF results show a clear upward trend with increasing nanosilver concentration: 32.98 ± 0.07 at 100 ppm, 33.04 ± 0.22 at 200 ppm, and 34.04 ± 0.28 at 300 ppm. This increment, although modest between 100 and 200 ppm, becomes more pronounced at 300 ppm, suggesting a dose-dependent enhancement of UV protection. The relatively small difference between 100 and 200 ppm may indicate an early saturation of UV absorption or scattering by the nanoparticles at lower concentrations, whereas the further increase to 300 ppm enters a more efficacious regime.

Silver nanoparticles can contribute to UV protection through several interrelated physical and chemical mechanisms. The surface plasmon resonance (SPR) effect allows AgNPs to strongly absorb and scatter light in the UV-visible spectrum, reducing the penetration of UV photons. The extent of this interaction depends on particle size, shape, and surface chemistry (e.g., capping agents)(19). For example, Palanki et al. showed that AgNPs in the 10–40 nm range offered stronger protection against UVB-induced damage in keratinocytes, whereas larger particles (> 40 nm) had diminished effects (20). AgNPs within the optimal particle size range exhibit relatively high SPF values, even at low concentrations.

Another contributing factor may be the synergistic effect of phytochemicals from the plant extract used in synthesis. The capping molecules (polyphenols, flavonoids) on the nanoparticle surface may also absorb UV or quench reactive species that would otherwise degrade surface structure under irradiation. This dual action—physical UV blocking plus chemical stabilization—can amplify protection beyond what bare metallic nanoparticles would provide (21).

AgNP dispersions with SPF values of approximately 33–34 exhibit excellent UV-protective capability, primarily attributed to the localized surface plasmon resonance (SPR) exhibited by particles ranging from 10 to 40 nm, which effectively absorb and scatter UV radiation. The presence of surface-capping phytochemicals, including flavonoids and polyphenols, further enhances this protection through supplementary UV absorption and antioxidant properties. Moreover, a well-dispersed particle system contributes to enhanced stability and maximized optical efficiency, thereby improving skin protection against UV-induced damage.

CONCLUSIONS

This study demonstrated that silver nanoparticles (AgNPs) synthesized through a green method using Kweni (*Mangifera odorata* Griff.) leaf extract possess significant sunscreen potential. The *in vitro* SPF evaluation revealed that increasing nanoparticle concentration from 100 to 300 ppm slightly enhanced SPF values from 32.98 ± 0.07 to 34.04 ± 0.28 , indicating a concentration-dependent improvement in UV protection capability. These results suggest that biosynthesized AgNPs can serve as an effective natural photoprotective agent due to their ability to absorb and scatter UV radiation, as well as possible synergistic effects from phytochemical capping compounds.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest related to the present study.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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