Advancing Lotion Formulation Research: Harnessing the Potential of *Moringa oleifera* and Shea Butter for Enhanced Skin Health

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Abstract

Background: *Moringa oleifera* is renowned for its myriad of bioactive constituents that manifest exceptional anti-oxidative and anti-inflammatory benefits. Recent advancements have evidenced the potential of *Moringa oleifera* nanoparticles in enhancing ultraviolet (UV) protection, promoting deeper skin absorption, ensuring prolonged efficacy, and augmenting the overall quality of skincare formulations. Given their fluid nature and substantial aqueous composition, lotions represent an ideal medium for direct dermal application, aiming at ameliorating skin conditions and fortifying the skin's protective barrier. Objective: This investigation endeavours to develop a lotion incorporating *Moringa oleifera* nanoparticles, aiming to synergize the inherent merits of *Moringa oleifera* with the nanotechnology's capabilities for superior UV defence and enhanced skin permeability. Methodology: The extraction of nanoparticles entailed a sequential procedure culminating in the synthesis of silver nanoparticles. The lotion's composition was structured into three distinct phases: an oily phase (comprising emulsifying wax and shea butter), a water phase (incorporating distilled water, kaolin, and the nanoparticle extract of *Moringa oleifera*), and an additive phase (including benzoic acid and fragrance), utilizing a double-boil technique for the formulation. Quality and longevity of the lotion were evaluated through pH and centrifugal stability tests. Results: Characterized by an appealing aesthetic, substantial moisture content, enhanced texture, mitigating inflammation, and effective hydration capabilities, the formulated lotion demonstrated promising results. The stability assessments corroborated its quality. Conclusion: The novel lotion formulated with *Moringa oleifera* nanoparticles exhibits significant potential in hydrating and repairing skin.

Keywords: Lotion Formulation, *Moringa oleifera*, Shea Butter, Skin Health

Significance | The integration of *Moringa oleifera* nanoparticles and shea butter in lotion represents a groundbreaking milestone in skincare. This fusion offers profound benefits, including deep hydration and potent anti-inflammatory properties.

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Introduction

Lotions are essential for dermatological health, offering hydration and enhancing skin vitality. Rheological properties turn out to be highly important in relation to the hydration efficacy of lotions within the medium range of viscosity values because they are easily and rapidly absorbed by the skin. This feature is especially beneficial for individuals with dry skin, as the regular application of lotions can provide sustained moisture retention and establish a protective barrier. This barrier effectively combats dryness, texture irregularities, itching, and minor skin irritations, thereby alleviating various dermatological concerns. Furthermore, lotions facilitate the

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effective absorption of moisture and are instrumental in the assimilation of fat-soluble vitamins (Hassan et al., 2021).

Moringa oleifera (MO) has emerged as an exceptionally promising botanical additive, rich in bioactive compounds such as vitamins, flavonoids, phenolic acids, isothiocyanates, tannins, saponins, and potent antioxidants, including vitamins C, D, E, and polyphenols (Vergara-Jimenez et al., 2017, Rolla et al. 2023). These compounds play a crucial role in counteracting oxidative stress and may contribute to reducing the prevalence of certain cancers. MO leaves have demonstrated superior efficacy in addressing inflammatory skin conditions through their synergistic action and the enhancement of antioxidant cascades (Vergara-Jimenez et al., 2017).

Moreover, shea butter is recognized for its profound moisturizing capabilities, UV protection, and anti-aging properties, alongside its role in mitigating inflammation (Israel, 2015). The combination of MO and shea butter into lotions represents a major advancement in skincare technology, promising unprecedented levels of efficacy and skin nourishment.

The synthesis of silver nanoparticles (AgNPs) through plant extracts has emerged as a field of considerable interest, showcasing the potential for a wide range of medical applications. This research explores the synthesis process and thorough characterization of nanoparticles, highlighting their promising future in therapeutic settings (Mittal et al., 2013).

By meticulously investigating the combined effects of MO and shea butter, along with the innovative approach to nanoparticle synthesis, this study sets the stage for transformative breakthroughs in skincare formulation. It aims to introduce cutting-edge lotion compositions that not only optimize skin health but also address a broad spectrum of dermatological needs, marking a significant advancement in cosmetic science and dermatology.

2. Materials and Methods

2.1 Sequential Extraction

The nanoparticles of MO were extracted using a sequential method with solvents of varying polarity. Firstly, 25g of MO leaf powder was mixed with 250 ml of ethanol and sonicated for 30 minutes. The mixture was then centrifuged at 6000 rpm for 15 minutes, and the resulting supernatant (ethanol extract) was collected. This process was repeated until all the ethanol extract was centrifuged. The collected supernatant was filtered, and the clear extract was obtained. The remaining pellets were reused by mixing them with a solvent mixture of deionized water and 50% ethanol. After filtration, the supernatant was freeze-dried to obtain the extract. The pellets were dried in a fume hood before being mixed with 250 ml of deionized water to produce the deionized water extract, which was also freeze-dried. This sequential extraction method started with ethanol and progressed to deionized water, moving from non-polar to polar solvents.

2.2 Green Synthesis of 1% Nanoparticles

To synthesize nanoparticles, 33.974 mg of silver nitrate (AgNO3) was weighed and mixed with 200 ml of deionized water. The weight of AgNO3 was calculated using the formula below:

The molecular weight of AgNO3= 0.16987 mg

0.16987 mg = 1 ml

X mg= 200 ml

X mg= 33.974 mg (AgNO3)

An aqueous extract of MO was prepared and dissolved in deionized water. The nanoparticle preparation ratio was 1:9, with 20 ml of the aqueous extract and 180 ml of AgNO3 solution used to prepare 200 ml of nanoparticles. Spectrophotometer readings were taken at (0, 1, 2, 4, and 8) hours, using the AgNO3 solution as a blank and the AgNO3 with extract as the sample. The solution was then placed in a water bath shaker at 60°C. The color of the solution changed from yellowish to dark brown during the (0 to 8) hr period. The resulting solution was centrifuged for 30 min at 6000 rpm, and the nanoparticles were harvested by rinsing the precipitate three times with deionized water (Figure. 1). The collected precipitate was frozen and freeze-dried for further use.

2.3 Preparation of Lotion

The lotion formulation includes various ingredients such as distilled water, emulsifying wax, shea butter, benzoic acid, kaolin, extract, and fragrance (Table 1). Distilled water acts as a solvent and facilitates the dissolution of other ingredients, forming emulsions that combine oil and water components to create lotions (Banerjee et al., 2016). Emulsifying wax is ideal for blending lotions with oil and water, providing stability and moisturizing properties (Leal et al., 2022; Souto et al., 2021). Shea butter has been used in cosmetics for its nourishing and conditioning effects on the skin, thanks to its high vitamin and fatty acid content (Maanikuu & Peker, 2017). Benzoic acid is commonly used as a preservative and pH adjuster in skin care formulations to prevent bacterial growth (Shitole et al., 2022). Kaolin serves as an exfoliator, cleansing and removing dead skin cells, while also adding texture and bulk to the product (Meyrkhanova et al., 2019). The fragrance is added to enhance the user experience and mask any unwanted smells from the formulation (Radis-Baptista, 2023). Lastly, the key ingredient, nanoparticles extract of MO (Figure 1), enhances the performance of the lotion and meets customer needs, offering benefits such as improved UV protection and deeper skin penetration (Wiechers & Musee, 2010).

The preparation of the lotion involves weighing the ingredients and transferring them to the water bath to initiate the double boiling process. The lotion formulation consists of three phases (Table 2).

Table 1. List of the components used in the lotion formulation process

Ingredient
Distilled water
Shea butter
Emulsifying wax
Benzoic acid
Kaolin
Extract
Fragrance

Table 2. Components of the three phases used in the formulation process

Phase A (Oil Phase)	Phase B (Water Phase)	Phase C (Additional Phase)
Emulsifying Wax	Distilled water	Benzoic acid
Shea Butter	Extract	Fragrance
	Kaolin	

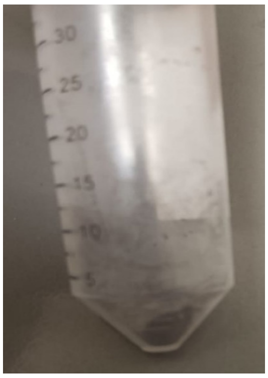

Figure 1. MO-AgNPs

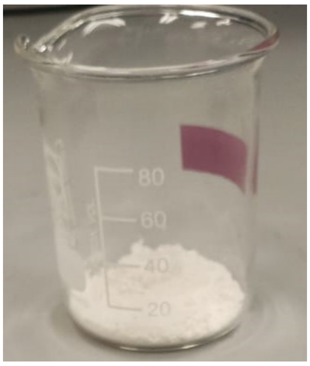

Figure 2. Phase C (Additional phase)

Figure 3. The Melting process

Figure 4. The Final product of oil-in-water lotion

Phase A is the oil phase, comprising emulsifying wax and shea butter. Phase B is the water phase, including ingredients like distilled water, kaolin, and nanoparticles of MO extract. Phase C, known as the additional phase, serves to stabilize the ingredients and prevent volatility (Singal et al., 2011) (Figure 2). This phase contains benzoic acid and fragrance.

After melting the oil phase (Figure 3), it was combined with the aqueous and additional phases, and the mixture was homogenized. Phase B was added before Phase A to ensure the production of an oil-in-water lotion (Figure 4), which offers several advantages, including high dispersibility, good penetration, a non-greasy feel, and easy removal with water. Additionally, it has significant water content, making it easy to apply (Fransiska et al., 2021). Stability testing was conducted to ensure product quality. Stability testing is crucial for determining the product's shelf life, storage conditions, and overall quality for consumers (Restu et al., 2015).

3. Results and Discussion

The study on lotion formulation revealed significant achievements, highlighting a blend made from distilled water, emulsifying wax, and shea butter as its main ingredients. This formulation consisted of 70% distilled water, 12.7% emulsifying wax, and 11% shea butter, each playing a crucial role in the lotion's overall properties. Distilled water functioned as an essential solvent, promoting a lightweight texture for swift skin absorption. The inclusion of emulsifying wax not only ensured the lotion's textural consistency and stability but also facilitated its even application. Shea butter, recognized for its vitamin richness, served as a potent emollient to augment skin hydration and suppleness (Calixto et al., 2018).

MO nanoparticles formed the central ingredients in a lotion and were characterized by broad-spectrum antimicrobial properties. MO has shown activities against many types of microbial agents, such as Gram-positive and Gram-negative bacteria, fungi, viruses, and parasites. In addition to its antimicrobial effect, MO would favor regeneration mechanisms through an enhancement of the inflammatory response by stimulating tissue regeneration and promoting the proliferation of fibroblasts (Xiao et al., 2020). This comprehensive lotion formulation thus offers hydration, skin soothing, barrier reinforcement, and moderate anti-inflammatory benefits.

The rationale for incorporating MO derived from the historical utilization of medicinal plants in crafting effective therapeutics (Süntar, 2020). MO was specifically selected for its anti-inflammatory attributes and its protective efficacy against arsenic toxicity. The formulation process leveraged surfactants (emulsifying wax) and co-surfactants (distilled water) for optimal ingredient integration, effectively reducing interfacial tension between the water and oil phases. A High-Pressure Homogenizer was employed to attain the desired nanoparticle size, utilizing high pressure and shear forces to achieve precise particle reduction. The lotion's pH was meticulously adjusted to align with that of healthy skin, thereby minimizing irritation risks (Hanifah & Jufri, 2018).

Evaluation metrics for the MO-based lotion encompassed assessments of its physical properties and particle size, highlighting its appealing scent, smooth texture, and compatibility with normal skin types. It delivered moisturization effectively without a greasy aftermath. The formulations were further enhanced by the addition of green tea emulsion, aimed at improving visual appeal and consumer attraction by mitigating the presence of tiny black particles from MO nanoparticles (Senanayake, 2013). Future research will investigate advanced particle size quantification techniques, including dynamic image analysis (DIA), static laser light scattering (SLS), dynamic light scattering (DLS), and sieve analysis. These methodologies are expected to yield deeper insights into the lotion's physical characteristics and inform enhancements for subsequent formulations (Contado, 2022; Gerstler et al., 2023).

4. Conclusion

This work has therefore been a leap into the development of innovations in skincare through the formulation of Moringa oleifera nanoparticles and shea butter into a novel lotion formulation. Through a detailed extraction process, we've developed a product that's both safe and highly effective, characterized by its clean white appearance and quick-absorbing, slightly greasy texture. This lotion stands out for its potent anti-inflammatory and moisturizing properties, attributed to the MO nanoparticles and shea butter. Emphasizing the importance of proper storage away from humidity, sunlight, and air to maintain its effectiveness, we recommend keeping the lotion at a stable room temperature of around 25°C. This development not only opens new avenues for natural skincare products but also sets the stage for further in vivo and clinical studies to solidify its efficacy and market potential, promising enhanced skin health and well-being.

Author contributions

Nozlena abdul samad and Rolla Al-Shalabi conceived the study. Nozlena abdul samad developed the theoretical framework, conceived, planned the experiments and contributed to the final version of the manuscript and supervised the project and Rolla Al-Shalabi performed the experiments/calculations/simulations, analysed the data and wrote the manuscript. Lim Vuanghao. and Julia Joseph aided in the analysis. All authors discussed the results, provided critical feedback and helped shape the research, analysis and contributed to the final manuscript.

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Competing financial interests

The authors have no conflict of interest.

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