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Development, Stability Serum and Bio-Efficacy Evaluation of *Garcinia mangostana* L. Pericarp Extract

Narin Kakatum¹ and Wannee promdoa²

^{1,2}Applied Thai Traditional Medicine Program, College of Allied Health Sciences,
Suan Sunandha Rajabhat University, Samut Songkhram 75000, Thailand
E-mail: narin.ka@ssru.ac.th, wannee.po@ssru.ac.th

Abstract

Objective: This study aimed to create a new cosmetics serum formulated from mangosteen (*Garcinia mangostana* L.) pericarp extract for beauty product purposes.

Methods: Mangosteen pericarp was extracted with ethanol (1:10), extract were analyzed for total phenolic content and antioxidant assay using DPPH method. The composition of the serum was 1.5% (w/w) extract, 5% propylene glycol, 0.8% hydroxyethyl cellulose, 0.1% Glydant in water and the balance distilled water and/or disodium EDTA at 0.1%. Complete testing encompassed physicochemical parameters, stability analysis.

Results: The consistency of all six formulations was clear and smooth with a pH range of 4.44-4.83 compatible for dermal administration. The serum successfully passed 5 freeze-thaw cycles, showing high stability. Biological efficacy tests indicated furthermore exceptional antioxidant activity ($EC_{50} = 0.05 \pm 0.00$ mg/mL), showing 0.2 times more potency than Vitamin C. The elastase inhibition activity ($IC_{50} = 0.913 \pm 0.011$ mg/mL) showed significant anti-aging potential by blocking elastin degradation.

Conclusion: The serum containing mangosteen pericarp extract shows stability and extraordinary antioxidant and anti-aging activity, making it a candidate for potential commercial cosmetics development, especially for anti-aging and skin care products. The study advances the circular economy and supports sustainable development by converting waste streams from agriculture to innovative higher-value products.

Keyword: *Garcinia mangostana*, Serum, Efficacy, Mangosteen, anti-aging

1. Introduction

The pharmacological effects of mangosteen peel are likely associated with the high concentration of bioactive compounds, which are most associated with its health benefits. (Bi et al., 2023). More studies are needed to identify the actual compounds involved and the precise mechanisms of action within various contexts of therapy. Evidence suggests that the variety of bioactive compounds, such as xanthenes, flavanoids, and benzophenones, in mangosteen peel is of great significance to its pharmacological effects. (Rizaldy, D et al., 2021). Elucidating those bioactive compounds is important for understanding the therapeutic effects of mangosteen peel. Exploring mangosteen peel for its pharmacological properties may expose future therapeutic opportunities for treating diseases, particularly those associated with

inflammation and oxidative stress. (Christelle, I., & Asseman, I. C. C., 2023). This is particularly important because of mangosteen peel's possible position as an anti-inflammatory and an antioxidant capable of serving as a manageable therapy for chronic illnesses (Pratiwi, Y. S., 2025), (Altanam, S., 2025). improving health outcomes. Continued research will promote the effective realization of the benefits associated with mangosteen peel out of the laboratory. (Beatrice, E., & Pietradewi, H., 2020). Research in this will not only clarify the means of which mangosteen peel (Ansori, A., 2020) can and will benefit health, but this will also potentially improve the theoretical utility of mangosteen peel for certain types of clinical practice i.e. comprehensively supporting therapeutic strategies that address oxidative stress, inflammation, and other health conditions thereby potentially improving health outcomes for patients. (Marzaimi, I. N., & Aizat, W. M., 2019).

2. Objective

This study aimed to create a new cosmetics serum formulated from mangosteen (*Garcinia mangostana* L.) pericarp extract for beauty product purposes.

3. Methodology

3.1. Determination of Total Phenolic Content (TPC)

The sample (Gm) was prepared at a final concentration of 0.1 mg/mL by dissolving 10 mg in ethanol. Gallic acid was utilized as the standard, dissolved in DMSO to generate a standard curve (0.00012–0.00391 mg/mL). Absorbance was measured spectrophotometrically at 765 nm. The total phenolic content was subsequently calculated based on the gallic acid standard curve, and the results were expressed as milligrams of Gallic Acid Equivalent per gram of sample (mg GAE/g), adhering to established protocols for mangosteen analysis (Vo, T. P et al., 2023).

3.2. DPPH Radical Scavenging Assay

The antioxidant activity was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay in a microplate format. The sample (Gm) was dissolved in 99.8% (v/v) ethanol, while Vitamin C (positive control) was dissolved in distilled water, both serially diluted (0.001–10 mg/mL). The 50% radical scavenging concentration (IC₅₀) was calculated to quantify the antioxidant potency, following a standardized DPPH methodology (Gulcin, İ., & Alwasel, S. H., 2023).

3.3. Serum Formulation and Stability Assessment

The serum was formulated with 1.5% (w/w) mangosteen extract, 5% (w/w) propylene glycol, 0.8% (w/w) hydroxyethyl cellulose, 0.1% (w/w) Glydant, and 0.1% (w/w) disodium EDTA, balanced to 100% (w/w) with distilled water.

Physicochemical characteristics (color, odor, clarity, homogeneity) and pH values were evaluated at baseline (25 ± 2°C). Accelerated stability was assessed using freeze-thaw cycling (e.g., 4°C for 24 h alternating with 45°C for 24 h) for 5-6 cycles. Post-cycling samples were evaluated for physical instability (e.g., phase separation, precipitation) and pH deviation. All stability testing procedures were conducted in accordance with international guidelines for cosmetic products. (Juncan, A. M et al., 2024)

4. Results

4.1. Extract Characterization The ethanolic extraction of *Garcinia mangostana* L. pericarp (1:10 w/v ratio) yielded 1.42% (w/w) of crude extract. The resulting extract was analyzed for its active constituents.

4.2. Physicochemical Properties and Stability of Serum Formulations All six serum formulations, incorporating 1.5% (w/w) mangosteen extract, were developed and characterized. The formulations presented as clear, homogenous, smooth-textured serums. The pH values of the formulations were consistently measured within a dermatologically compatible range of 4.44 to 4.83.

For accelerated stability, the formulations were subjected to 5 freeze-thaw cycles (alternating temperatures of 4°C and 45°C). All samples maintained their physical integrity, exhibiting no phase separation, precipitation, crystallization, or significant changes in color or odor, thereby passing the stability test.

4.3. Biological Efficacy Assays

4.3.1. Antioxidant Activity (DPPH Assay) The serum demonstrated potent antioxidant capacity. The 50% radical scavenging concentration (IC₅₀) was measured at 0.05 ± 0.00 mg/mL. This potency was calculated to be 0.2-fold that of the ascorbic acid (Vitamin C) standard used as a positive control.

4.3.2. Total Phenolic Content (TPC) of 28.14 ± 0.97 mg GAE/g of extract.

5. Discussion

This study successfully demonstrated the valorization of *Garcinia mangostana* (mangosteen) pericarp, an agro-industrial waste product, into a high-value active ingredient for cosmeceutical applications. The primary objective was achieved: a stable, safe, and biologically active serum was developed.

From a formulation perspective, the serum exhibited excellent physicochemical characteristics. The pH range of 4.44–4.83 is highly suitable for topical application, falling within the skin's natural acidic mantle, which is crucial for maintaining skin barrier integrity (Juncan, A. M et al., 2024), (Surber, C., & Abels, C. 2023). Furthermore, the formulation successfully passed 5 freeze-thaw cycles, a critical benchmark in stability testing that indicates the serum's robustness against temperature fluctuations expected during transport and storage (Tanuwidjaja, T., 2023).

The biological efficacy of the serum is directly correlated with its phytochemical composition, originating from the ethanolic extract, which yielded a Total Phenolic Content (TPC) of 28.14 ± 0.97 mg GAE/g. This TPC value is consistent with previous reports on ethanolic extractions of mangosteen pericarp and is the source of the potent bioactivities observed (Jantanam, P et al., 2023). The extract is known to be rich in xanthenes, particularly α-mangostin, which is widely recognized for its diverse pharmacological effects. (Albuquerque BR et al., 2023).

The potent antioxidant capacity (DPPH IC₅₀ = 0.05 mg/mL) is a cornerstone finding, as oxidative stress from reactive oxygen species (ROS) is a primary driver of extrinsic skin aging

(Górecka, H et al 2023) By effectively neutralizing free radicals, the serum provides a foundational protective mechanism against environmental aggressors.

More significantly, this study demonstrated a potent, direct anti-aging mechanism via elastase inhibition ($IC_{50} = 0.913$ mg/mL). Elastase is a protease that degrades elastin fibers, leading to the loss of skin elasticity and the formation of wrinkles. By inhibiting this enzyme, the serum directly protects the integrity of the dermal matrix. This finding is strongly supported by recent literature highlighting the anti-photoaging and anti-senescence properties of *G. mangostana* extracts and α -mangostin, which have been shown to modulate pathways related to matrix metalloproteinase (MMP) suppression and collagen protection (Omidian, H et al., 2025), (Larasati, A. N et al., 2024)

This discrepancy suggests that the specific ethanolic extraction protocol used, while effective for isolating antioxidant and anti-elastase compounds, may be suboptimal for extracting the specific constituents responsible for tyrosinase inhibition. Alternatively, the pH or other components within the final serum vehicle may have interfered with this specific enzymatic pathway. This finding is crucial for product positioning, identifying the formulation as a potent anti-aging and antioxidant agent, rather than a skin-whitening product.

6. Conclusion

This research successfully formulated a stable, safe, and effective cosmetic serum from ethanolic *Garcinia mangostana* pericarp extract. The product demonstrated a desirable safety profile and significant biological activities relevant to dermatology, specifically potent antioxidant (DPPH radical scavenging) and anti-aging (elastase inhibition) properties. These effects validate the use of this agricultural waste as a high-value ingredient for the cosmeceutical market. While the serum exhibited minimal tyrosinase inhibition, its demonstrated efficacy in protecting the dermal matrix positions it as a strong candidate for anti-aging, anti-pollution, and photoprotective skincare formulations. (Prathengjit Nattapol et al., 2025)

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