Utilization of Bidara Leaf Extract (*Ziziphus mauritiana Lamk*) as a Body Scrub For Skin Care

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Abstract

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Body scrub is a skincare product designed to exfoliate dead skin cells. Bidara leaf extract (Ziziphus mauritiana Lamk) was selected for its flavonoid, saponin, and tannin content, which contribute to antibacterial and antioxidant properties, while Epsom salt functions as an exfoliating agent that aids in dead skin removal and enhance skin regeneration. This study involved variations in bidara leaf extract concentration (0–5%) and Epsom salt concentration (10–50%). The formulations were evaluated through physical quality tests, including pH, homogeneity, adhesion, spreadability, organoleptic properties, antibacterial activity, and antioxidant activity. Results indicated that the formulation with 1% bidara leaf extract and 20% Epsom salt yielded the best outcomes, with a pH of 5.2 (compliant with SNI standards for topical preparations), good homogeneity, soft texture, and high panelist acceptance, particularly for sensitive skin. Antibacterial testing revealed the highest activity at 1% extract concentration, with an inhibition zone of 23 mm against Staphylococcus aureus. Antioxidant activity demonstrated free radical inhibition with an IC50 value of 18.94 µg/mL. These findings suggest that body scrub formulations incorporating bidara leaf extract and Epsom salt hold potential as natural, effective, and environmentally friendly skincare products.

1. Introduction

The global trend in the cosmetics and skincare industry is currently shifting towards products made from natural ingredients (*back to nature*). This is driven by increasing consumer awareness regarding the safety and potential long-term side effects of synthetic ingredients, as well as environmental sustainability[1]. Body scrub, as a body care product that functions to cleanse, remove dead skin cells (*exfoliate*), and hydrate the skin, is one of the products widely developed by utilizing natural resources[2].

Skin is the largest organ of the human body and serves as the primary barrier against environmental aggressors such as ultraviolet (UV) radiation, pollutants, and microbial contaminants. Daily exposure to these stressors accelerates skin aging and can lead to dryness, roughness, and hyperpigmentation if appropriate skin care is not practiced. Exfoliation is an important component of skin-care routines because it facilitates the removal of corneocytes, improves skin texture, and enhances the penetration of topical agents[3].

In recent years, there has been a marked shift from conventional synthetic cosmetics toward natural and herbal-based formulations. Consumers increasingly associate “natural” or “herbal” cosmetics with better safety profiles, fewer adverse effects, and additional therapeutic benefits. Plant-derived ingredients rich in bioactive compounds, such as polyphenols, flavonoids, and triterpenoids, are widely used in skin-care products for their antioxidant, anti-inflammatory, moisturizing, and photoprotective properties. This trend is also supported by increasing scientific and patent literature focusing on natural ingredients for cosmetics and “clean beauty” concepts.

Body scrubs are popular cosmetic products designed to mechanically exfoliate the stratum corneum by combining abrasive particles with an appropriate base and functional additives. A well-formulated scrub should effectively remove dead skin cells while maintaining barrier integrity and minimizing irritation. Traditionally, synthetic microbeads and aggressive surfactants were frequently employed as exfoliating and cleansing agents; however, concerns about microplastic pollution and skin irritation have driven interest in natural exfoliants and herbal scrubs[4]. Recent studies on herbal facial and body scrubs demonstrate that plant-based formulations can provide gentle exfoliation together with antioxidant, antimicrobial, and anti-aging benefits[5]. Herbal exfoliants derived from plant materials have also been reported to support skin renewal by

promoting desquamation and reducing the impact of both intrinsic and extrinsic aging processes[6].

Ziziphus mauritiana Lamk, commonly known as Indian jujube or bidara, is a member of the family Rhamnaceae and is widely distributed in tropical and subtropical regions. It is traditionally used in various ethnomedicinal systems for the management of ailments including digestive disorders, fever, inflammation, infections, and metabolic diseases[7]. Comprehensive reviews have highlighted that different parts of Z. mauritiana (fruits, leaves, bark, and seeds) contain diverse phytoconstituents such as flavonoids, saponins, tannins, triterpenoids, and phenolic acids, which are responsible for its wide range of pharmacological activities[7].

Among the plant parts, the leaves of Z. mauritiana are particularly rich in phenolic compounds and flavonoids and have been extensively investigated for their biological activities. Phytochemical and bioactivity studies show that leaf extracts exhibit strong free-radical-scavenging capacity, often correlating with high total phenolic and flavonoid contents. Methanolic and ethanolic leaf extracts have demonstrated notable antioxidant, antibacterial, and anti-inflammatory properties in vitro and in vivo, supporting their potential use as natural active ingredients in skin-care formulations[8].

In addition, an acute oral toxicity study on Z. mauritiana leaf extract reported no significant toxic effects at high doses while confirming considerable antioxidant activity, indicating a favorable safety profile[9]. These characteristics—antioxidant, antimicrobial, anti-inflammatory effects and acceptable safety—are desirable for cosmetic ingredients intended to protect the skin from oxidative damage, help control skin-associated microbes, and support overall skin health[10].

Despite the extensive pharmacological evidence for Z. mauritiana leaves, their utilization specifically in cosmetic formulations—such as body scrubs—remains limited in the scientific literature. Previous works on herbal scrubs have focused on other botanicals (for example neem, tulsi, guava, or polyherbal blends) and primarily evaluated general parameters such as organoleptic properties, pH, spreadability, viscosity, and microbial stability[11]. To date, reports on the incorporation of Z. mauritiana leaf extract into exfoliating products for skin care are scarce, and there is a lack of systematic evaluation of its cosmetic potential in this dosage form.

Therefore, this study aims to develop and evaluate a body scrub formulation containing bidara (Ziziphus mauritiana) leaf extract as a natural active ingredient for skin care. Specifically, the objectives are to formulate a stable body scrub using Z. mauritiana leaf extract and suitable natural exfoliating and base components, and to assess its physicochemical characteristics and selected functional properties relevant to skin care. The results are expected to provide a scientific basis for the cosmetic utilization of bidara leaves and to contribute to the development of herbal body scrubs that are both effective and environmentally friendly.

The extract of bidara leaves (*Ziziphus mauritiana Lamk*) exhibits antibacterial activity against various pathogens, including the bacteria *Escherichia coli*, *Pseudomonas aeruginosa, Salmonella typhi, Staphylococcus epidermidis, Streptococcus mutans,* and *Vibrio sp*. This is because bidara leaves (*Ziziphus mauritiana Lamk)* contain active compounds such as alkaloids, flavonoids, saponins, tannins, and phenols [3]. The activity of these compounds enables bidara leaves to support skin health by scavenging free radicals [4].

Epsom salt, which is rich in magnesium sulfate, acts as an effective exfoliant. In addition to removing dead skin cells, Epsom salt also helps enhance muscle relaxation and improve blood circulation. Research by Santosa et al. [5] demonstrated that Epsom salt gel as a topical medication is effective in reducing pain levels, highlighting its therapeutic potential for skincare applications. A stable scrub base was formulated using emulsifying wax NF as an emulsifier, almond oil as an emollient, and other supporting ingredients to ensure a homogeneous and safe product.

The use of body scrub formulated with bidara leaf extract (*Ziziphus mauritiana Lamk*) and Epsom salt provides significant benefits for skin care. This combination is effective in soothing sensitive skin, reducing irritation, and accelerating the regeneration process and the healing of minor wounds. Furthermore, the Epsom salt content provides a deep relaxing effect on the skin and muscles.

As the physical exfoliant in this formulation, Epsom salt (magnesium sulfate)

was chosen. Epsom salt not only functions to mechanically remove dead skin cells with its granules but also provides therapeutic benefits. Magnesium sulfate can penetrate the skin, helping to relieve muscle pain, reduce inflammation, and enhance relaxation, thereby adding functional value to the body scrub [5, 6].

While previous studies have examined the antibacterial and antioxidant activities of bidara leaf extract [2, 3], research on its application in body scrub formulations remains limited. The complexity of cosmetic formulations can influence the bioavailability and efficacy of active compounds. Therefore, this study aims to develop and identify the optimal concentration of bidara leaf extract and Epsom salt for body scrub quality, as well as to evaluate its effectiveness on the skin. It is hoped that this product can become an effective, economical, and environmentally friendly skin care solution.

2. Methods

2.1 Materials and Equipment

Materials used included 70% ethanol, bidara leaves, cetyl alcohol, virgin coconut oil, shea butter, almond oil, emulsifying wax NF, Epsom salt, essential oil, optiphen, tocopherol.

The equipment used included a rotary evaporator, UV-Vis spectrophotometer, hot plate, watch glasses, stainless steel whisks, immersion blender, spatula, glass stirring rods, analytical balance, beaker glasses, pH meter, laboratory oven, measuring cylinders.

2.2 Preparation and Extraction of Bidara Leaves

Fresh bidara leaves were washed, dried at 40ºC for 6 hours, and then ground into powder. The powder was macerated with 70% ethanol for 2 days, and the filtrate was concentrated using a rotary evaporator at 50ºC.

2.3 Body Scrub Formulation

The body scrub was formulated with variations in bidara leaf extract concentration (0%, 1%, 2%, 3%, 4%, 5%) and Epsom salt concentration (10%. 20%, 30%, 40%, 50%). The base ingredients consisted of cetyl alcohol, emulsifying wax NF, almond oil, virgin coconut oil, shea butter, optiphen, tocopherol, and essential oil. The manufacturing process involved heating at 40-45ºC and cooling in freezer at 18ºC. After the mixture solidified, it was stirred with the addition of Epsom salt until homogeneous.

The scrub base was formulated with ingredients selected for their specific functions to ensure stability, efficacy, and safety; Cetyl Alcohol acts as a co-emulsifier and thickener, improving the viscosity and stability of the emulsion, which helps suspend the Epsom salt particles evenly[12]. Emulsifying Wax NF, a non-ionic emulsifier, is crucial for forming a stable mixture between the oil and water phases, preventing separation, and providing a smooth, consistent texture[13].

Almond oil functions as an emollient, rich in omega-3 and Vitamin E. It helps to nourish the skin, improve moisture retention, and reduce signs of aging[14]. Virgin Coconut Oil (VCO) and Shea Butter were used as additional emollients and skin conditioners. VCO provides moisturization and has known antimicrobial properties, while shea butter soothes and protects the skin barrier. Tocopherol (Vitamin E) serves as an antioxidant that protects the oils and fats in the formulation from oxidative damage (rancidity), thereby extending the product's shelf life and providing antioxidant benefits to the skin[15].

Optiphen is a broad-spectrum and paraben-free preservative. Its inclusion is essential to prevent microbial contamination during storage and use, ensuring the product's safety [16]. Epsom Salt (Magnesium Sulfate) is the primary physical exfoliant. Its granular texture mechanically removes dead skin cells. Additionally, it is known to help soothe the skin and reduce inflammation [5, 6].

2.4 Testing Procedure

2.4.1 pH Test

The pH of the formulations was determined by dissolving 1 g of the sample in 100 mL of distilled water and measuring it using a pH meter. The measured pH values for all formulations were found to be within the acceptable range of 4.5-8.0 for topical preparations, as stipulated by the SNI 16-4399-1996 standard.

2.4.2 Organoleptic Test

Visual and sensory analyses were conducted to assess the physical characteristics of the samples, including color, aroma, and texture, based on direct observation [2].

2.4.3 Homogeneity Test

Homogeneity was evaluated by placing 1 g of the sample on a watch glass and visually inspecting for consistency and the absence of aggregates or phase separation [2].

2.4.4 Adhesion Test

Adhesion was measured by placing 0.5 g of the sample in a petri dish, covering it with an inverted petri dish, and applying a 150 g weight for 5 minutes. The time required for the watch glass to separate was recorded, with effective adhesion defined as >4 seconds [2].

2.4.5 Spreadability Test

Spreadability was assessed by placing 0.5 g of sample in a petri dish, covering it with an inverted petri dish, and applying a 150 g weight for 1 minute. The diameter of the spread was measured, with a larger diameter indicating better spreadability and penetration potential [2].

2.4.6 Antibacterial Activity Assay

Antibacterial activity against *Staphylococcus aureus* was evaluated using the disk diffusion method. Sterilized paper disks were immersed in the body scrub samples for 2 minutes, placed on mueller hinton agar inoculated with bacterial suspension, and incubated at 37ºC for 24 hours. The inhibition zone diameter was measured in milimeters [7].

2.4.7 Antioxidant Activity Test

Antioxidant activity was determined using the DPPH free radikal scavenging method. Sample solutions at various concentrations were mixed with DPPH solution, incubated for 30 minutes, and absorbance was measured at 517 nm using a UV-Vis spectrophotometer. The percentage inhibition and IC_{50} value were calculated to quantify antioxidant efficacy [8].

3. Results and Discussion

3.1 Physical Characteristics and Organoleptic Properties

The physical evaluation of the bidara leaf extract body scrub formulations is summarized in Table 1. All formulations exhibited good physical stability. The pH values of all formulations range from 4.9 to 5.2, falling within the acceptable range of 4.5-8.0 for topical preparations as stipulated by the SNI 16-4399 standard[9]. The slight decrease in pH with increasing extract concentration (from 5.2 to 4.9) is likely attributed to the presence of phenolic and flavonoid compounds in the bidara leaf extract, which impart mild acidity [4]. This mildly acidic pH is advantageous as it aligns with the skin's physiological pH range (4.5-6.5), helping to maintain the protective acid mantle and inhibit the growth of pathogenic bacteria.

All formulations demonstrated excellent homogeneity without phase separation or visible aggregates, indicating a stable emulsion system capable of uniformly suspending Epsom salt particles.

Table 1. physical and organoleptic properties of body scrub formulations

Extract (%)	E. salt (%)	pH	Homogeneity	Adhesion (s)	Spreadability (cm)
0	20	5.2	Ɨomogeneous	55	4.7
1	20	5.2	Ɨomogeneous	55	4.8
2	20	5.1	Ɨomogeneous	51	4.8
3	20	5.0	Ɨomogeneous	45	5.0
4	20	4.9	Ɨomogeneous	45	5.1
5	20	4.9	Ɨomogeneous	39	5.2

Adhesion time decrease slightly with higher extract concentrations, from 55 seconds to 39 seconds. Despite this, all values significantly exceeded the minimum requirement of 4 seconds, indicating satisfactory product retention on the skin. Conversely, spreadability increased with higher extract content, from 4.7 cm to 5.2 cm, suggesting the extract may influence the rheological properties of the base, enhancing its spreadability.

Organoleptic evaluation revealed a progressive color change from white to greenish-brown as the extract concentration increased from 0% to 5%. The aroma was consistently dominated by the added rose essential oil, effectively masking the herbal scent of the extract. Texture was primarily governed by the Epsom salt concentration, a 20% salt content provides a soft, gentle exfoliation ideal for sensitive skin, while concentrations of 40-50% offered a more robust scrub suitable for normal or thick skin types.

3.2 Antibacterial Activity

The antibacterial activity against *Staphylococcus aureus* revealed a notable non-linear dose-response relationship (Table 2). The formulation with 1% bidara leaf extract and 20% Epsom salt yielded the largest inhibition zone of 23 mm.

Contrary to the expected trend of increasing efficacy with higher concentration, antibacterial activity peaked at 1% and markedly declined at concentration of 3-5% [10]. This phenomenon can be attributed to several factors as follows: At higher concentrations, bioactive compounds (e.g., flavonoids, saponins) may interact with other components in the scrub base (oils, waxes, Epsom salt), reducing their bioavailability and diffusion rate into the agar medium [7]. Physical Hindrance: The high viscosity of the formulation and the dense suspension of particles at high concentrations could physically impede the diffusion of antibacterial agents. Delayed Release: The significant inhibition zones observed after 5 days of incubation suggest a slow-release mechanism from the semi-solid cream base, where active compounds require extended time to diffuse and exert their effect.

Table 2. Antibacterial activity against *staphylococcus aureus*

Formulation	Inhibition Zone (mm)	Remark
Commercial Product (SZ)	9	Clear zone
0%	0	No zone
1%	23	Clear zone, largest
2%	18,5	Clear zone
3%	0	No zone
4%	0	No zone
5%	2	Faint zone at colony periphery

The 1% formulations demonstrated not only superior efficacy but also clear advantage over the commercial benchmark product (23 mm vs. 9 mm inhibition zone).

3.3 Antioxidant Activity

The antioxidant activity, determined by the DPPH free radical scavenging assay, is shown in figure 1. The formulation with 1% extract exhibited strong antioxidant activity, with percentage inhibition values ranging from 51.26% to 54.44% across tested concentrations (100-1000 ppm).

The IC_{50} value, representing the concentration required to scavenge 50% of DPPH radicals, was calculated to be 18.94 µg/mL. An IC_{50} value below 50 µg/mL is classified as strong antioxidant activity. This potent activity is attributed to the synergistic effect of flavonoids and phenolic compounds in the bidara leaf extract combined with the inherent antioxidant properties of other base ingredients like virgin coconut oil and shea butter [8, 11]. This suggests the formulated body scrub can provide protection against oxidative stress on the skin.

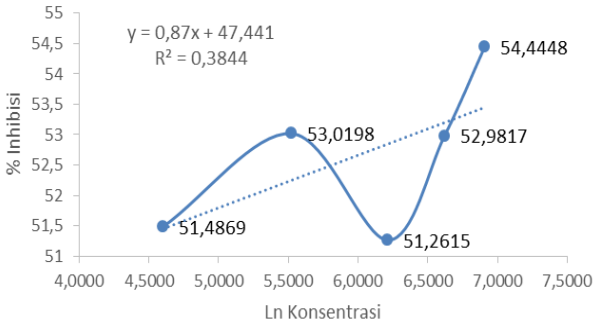

Figure 1. DPPH free radical scavenging activity of the 1% extract body scrub

4. Conclusion

The optimal formulation was achieved with 1% bidara leaf extract and 20% Epsom salt. This combination produced a body scrub with a skin-friendly pH (5.2), excellent physical properties, the highest antibacterial activity against *S. aureus* (23 mm inhibition zone), and strong antioxidant activity (IC_{50} = 18.94 µg/mL). The decline in antibacterial efficacy at higher extract concentrations (3-5%) underscores the importance of optimization within a complex formulation matrix. The study successfully demonstrates the potential of bidara leaf extract for developing effective, stable, and multifunctional natural body scrub products. Two product variants are recommended: a gentle version (1% extract, 20% salt) for sensitive skin and a robust version (1% extract, 40-50% salt) for normal/thick skin.

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