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Research Article

Design, Formulation and In-Vitro Evaluation of An Herbal Sunscreen Body Butter with Photoprotective Activity

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This study was conducted to design and evaluate an herbal sunscreen body butter using natural ingredients with moisturizing, and antioxidant activities and possessing potential protective effects on the skin. Sunscreen body butter was formulated consisting of shea butter, cocoa butter, olive oil, raspberry seed oil, aloe vera gel, lavender oil, and geranium oil. Various batches were formulated by altering the ratio of shea butter to the cocoa butter and evaluated using the appearance, smell, ease of application, washability, melting property, pH, acid value, and microbial stability. Out of the batches, Batch B3 with the shea butter: cocoa butter ratio of 7:3 yielded excellent results. The B3 batch exhibited a smooth and creamy appearance, an agreeable odor, ease of application, and was nongreasy, storable, had a pH value of 6.3, an acid value of 1.9, and inhibited the growth of microbes and also exhibited SPF 9.19. The findings indicate that the formulated herbal body butters are stable, have aesthetic appearance on the skin and have a potential to be used as a natural skin-care product.

Keywords: Herbal Sunscreen, Body Butter, Shea Butter, Raspberry Seed Oil, Photoprotection.

INTRODUCTION

UV Radiation and Skin Harm:

Solar ultraviolet radiation is a consequential ecological element that causes diverse kinds of dermal disorders, both instantaneous and long-term. Established on the wavelength, UV radiation is branched into three types: UV A (320-400 nm), UV B (280-320 nm) and UV C (100-280 nm). UV C is primarily blocked by the Earth's ozone layer and does not generally reach the surface. However, UV A and UV B can penetrate the skin and cause harmful effects [5,6]. UV A radiation goes deep into the skin's dermis and is mainly linked to photoaging which shows to wrinkles, loss of skin elasticity and early aging. It still culminates in reactive oxygen species, which source oxidative stress and damage to cells [5,7]. UV B radiation mainly affects the outer layer of the skin and is responsible for redness, sunburn, inflammation and direct damage to DNA [6,7]. Long-term exposure to UV radiation can lead to overproduction of melanin, causing hyperpigmentation and rough skin tone. Also, extended exposure can harm DNA and increase the risk of skin cancers [5,6]. These damaging effects have elevated the need for effectual sun protection measures, especially the dependable use of sunscreen.

Need for Sunscreens:

Every day exposure to UV radiation can cause sunburn, photoaging, hyperpigmentation, oxidative stress and a higher risk of skin cancer. Therefore, using a sunscreen regularly is an essential step to protect the skin from photodamage [5,6]. Sunscreens also help to maintain the skin health by preventing the breakdown of collagen and supporting the skin barrier function [7], conventional sunscreen contain chemical UV filters likes octinoxate which provide good protection. Moreover, these ingredients can cause

skin irritation and skin reactions and may also have environmental effect [1,6,10,11].

Herbal Sunscreens:

Herbal sunscreens used plant derivatives like extracts, oil and bioactive compounds to protect the skin from the dangerous effects of the UV radiation. Various botanical sources such as aloe vera, raspberry seed oil, green tea and turmeric are rich in polyphenols, flavonoids, carotenoids and vitamins that contribute to natural photoprotection. [6,7,15,19] the key mechanism involved in herbal sunscreens is antioxidant mediated protection, UV radiation generates ROS which causes oxidative stress, cellular damage and premature skin aging. Natural antioxidants available in plants help neutralize these free radicals thereby reducing the inflammation and support skin repair. [5,7] Compared to synthetic sunscreen agents, herbal ingredients offer additional benefits such as improved skin compatibility, moisturizing effects, antioxidant effects and reduced risk of irritation, further plant-based formulations are more environment friendly, sustainable and best alternative to modern skincare approach [1,6,10].

AIM:

To design, formulate, and evaluate a stable, cosmetically elegant herbal sunscreen body butter that provides effective skin hydration and photoprotection using plant-derived ingredients.

OBJECTIVE:

The principal objective of this research is to formulate, characterize and optimize body butter to enhance its physicochemical stability, sensory attributes and photoprotective efficacy for topical application.

Rationale:

The following rationale for the selected herbal ingredients used in the herbal sunscreen body butter formulation:

1. Aloe vera: Used for its soothing and anti-inflammatory properties, which improve skin hydration, support collagen synthesis, and aid in skin repair. [6]

2. Raspberry seed oil: Demonstrates broad-spectrum UV absorption (with an estimated SPF value between 28-50) and provides antioxidant protection due to its content of ellagic acid and tocopherols. [16]

3. Shea butter: A rich emollient abundant in vitamins A and E, which restores the epidermal lipid barrier, improves elasticity, prevents trans-epidermal water loss (TEWL), and supports wound healing. [2,6]

4. Cocoa butter: Used for its antioxidant-rich composition, which improves skin elasticity, softens the skin, and is effective in reducing dryness and the appearance of scars. [3,4]

MATERIALS AND METHODS:

This research employed a systematic formulation and evaluation approach to design an herbal sunscreen body butter. The methodology is divided into material acquisition, formulation design, and analytical evaluation to ensure reproducibility and product efficacy.

MATERIALS AND REAGENTS:

All ingredients utilized were of pharmaceutical or food-grade quality.

1. **Base Ingredients:** Shea butter (emollient) and Cocoa butter (consistency agent).

2. **Active Ingredients:** Raspberry seed oil was selected for its reported photoprotective efficacy [16].

3. **Aqueous Phase/Additives:** Aloe vera gel and a blend of essential oils (Lavender and Geranium) were used for therapeutic and sensory enhancement.

4. **Equipment:** The study utilized a double-boiler system for phase melting, an electronic analytical balance, an overhead laboratory stirrer for homogenization, a digital pH meter, and

standardized equipment for physical testing (spreadability).

Formulation Strategy:

A thermal method was adopted to achieve a stable emulsion:

1. **Phase A (Lipid Phase):** Shea butter and cocoa butter were weighed and melted in a double boiler at 60–70°C.
2. **Phase B (Oil Phase):** Carrier oils (Olive and Raspberry seed oils) were incorporated into the molten butter phase under constant stirring.
3. **Phase C (Active Phase):** Once the mixture cooled to 40°C, aloe vera gel was added to the oil blend.
4. **Whipping Process:** The final mixture was subjected to high-speed whipping to incorporate air and stabilize the structure, achieving the desired "fluffy" and creamy consistency.
5. **Fragrance incorporation:** Essential oils were added at the final stage to prevent thermodegradation of aromatic hydrocarbons.

Figure 1: Flow chart illustrating the preparation of herbal sunscreen body butter

Formulation of Body Butter:

This research focuses on developing a multifunctional herbal sunscreen body butter as a natural, safe alternative to synthetic UV protective agents. By combining shea butter and cocoa butter as a stable emollient base with photoprotective raspberry seed oil, the formulation provides effective skin barrier protection and nourishment. Olive oil and aloe vera gel were integrated to enhance spreadability, soothing effects and antioxidant capacity. Through systematic trial batches, the ratio of the lipid base was optimized to achieve an ideal balance.

Table 1: Formulation trial designs

Batch	Shea Butter (g)	Cocoa Butter (g)	Olive Oil (mL)	Raspberry Seed Oil (mL)	Aloe Vera Gel (g)	Essential Oil (mL)
B1	2	8	2	5	1	1
B2	3	7	2	5	1	1
B3	7	3	2	5	1	1
B4	6	4	2	5	1	1
B5	5	5	2	5	1	1

Evaluation Parameters:

The following parameters were evaluated to ensure the formulation meets the safety, stability and cosmetic standards required for high performance herbal sunscreen body butter.

1. **Appearance:** The evaluation assessed the visual quality and consumer appeal, criteria included color, uniformity, visual texture and consistency. (13,18)

2. **Odour:** As a critical sensory attribute for consumer preference, the fragrance intensity, pleasantness and consistency were evaluated immediately upon opening the container and after short term air exposure. (13)

3. **Spreadability:** It is a primary indicator of ease of application and active ingredient delivery. using the standardized glass slide method, 1 gm of body butter was placed between two glass plates under a 500gm weight for a minute. The resulting diameter (in cm) indicates the formulation's spreadability with larger diameters representing superior performance. (13,18)

4. **Washability:** This test determined the ease of product removal from the skin. After a 10–15-minute application period, the skin was rinsed under running tap water for 30 seconds to observe the ease of removal and the presence of residual films (18).

5. **Melting point determination:** to ensure the thermal stability and optimal skin melt behaviour, samples were placed in sealed capillary tubes and heated gradually in a controlled water bath to record the transition temperature from semi-solid to liquid (13).

6. **Absorption test:** this method measured the water holding capacity of the body butter base, 1 gm of body butter was stirred in distilled water until saturation indicated by separation and the final weight was recorded to quantify water uptake (13,18).

7. **pH measurement:** To ensure the skin biocompatibility, a 10% w/w dispersion of the formulation was prepared in distilled water and allowed to equilibrate for 30 minutes. The pH was then measured using a calibrated digital pH meter, targeting the ideal skin compatible range of 4.5-6.5 (13,18).

8. **Acid value:** The acid value was determined via titration to quantify free fatty acids, serving as a key indicator of lipid stability. The sample was dissolved in a neutral solvent and titrated with standardized potassium hydroxide, using phenolphthalein as an indicator to detect oxidative degradation or rancidity (13).

9. **Microbial growth:** Given the inclusion of aqueous ingredients, microbial safety was verified. Samples were collected under aseptic conditions, inoculated on selective media (nutrient agar) and monitored for colony formation at controlled temperature over a 3-7 days periods to ensure product shelf-life and safety (13).

10. **SPF determination:** To determine the SPF of a herbal sunscreen formulation, the Mansur equation method is typically employed via UV spectrophotometric analysis. A sample of the body butter is dissolved in a suitable solvent like ethanol to create a dilute solution, which is then scanned across the UV range 290-320 nm. The absorbance values are recorded at 5 nm intervals and multiplied by an EE* I constant. The SPF is calculated by taking the sum of these products and multiplying the result by a correlation factor, providing a quantitative estimate of the formulation's ability to block UV radiation and prevent skin damage (13,16).

$$\boldsymbol{SPF = CF \times \sum EE(\lambda) \times I(\lambda) \times Abs(\lambda)}$$

Where:

CF (Correction Factor) = 10

$EE(\lambda) \times I(\lambda)$ = Erythemal effect spectrum multiplied by the solar intensity spectrum (standard constants).

$Abs(\lambda)$ = Absorbance of the sample at wavelength λ

11. **Stability studies:** To ensure product integrity and shelf life, the formulation underwent stability testing following ICH and cosmetic industry guideline. Samples were stored in airtight containers and monitored for physical changes and chemical degradation over 15 days.

Room temperature (25°C ± 2°C): Conducted to simulate standard storage conditions and observe long-term product stability under ambient exposure [13,18].

Refrigerated (4°C ± 2°C): Performed to assess the formulation's resistance to cold-induced hardening or structural changes that could affect spreadability. [13,18]

RESULTS:

1. Appearance:

Table 2: Appearance Evaluation

Batch	Uniformity	Smoothness	Texture
B1	Slightly uneven	Moderate	Moderate gloss
B2	Fairly uniform	Moderate	Balanced gloss
B3	Very homogenous	Excellent	Balanced natural shine
B4	Slightly uneven spread	Moderate–Low	Reduced gloss
B5	Uniform cream colour	Good	Creamy matte-gloss balance

2. Odour:

Table 3: Odour Evaluation

Batch	Day 1	Day 7	Day 15
B1	Mild cocoa-shea blend	Changed	Fatty undertone
B2	Pleasant natural smell	Stable	Slight variation
B3	Balanced creamy aroma	Stable	Stable
B4	Slight cocoa dominance	Mild	Slight fatty note
B5	Pleasant creamy odour	Stable	Stable

3. Spreadability:

Table 4: Spreadability Evaluation

Batch	Shea:Cocoa Blend	Consistency	Spreadability (cm)
B1	High cocoa butter	Slightly less rigid	4.8 cm
B2	Moderate hardness	Semi-solid	5.6 cm
B3	Optimal solid-liquid ratio	Creamy, uniform matrix	7.8 cm
B4	Slightly firm structure	Mild resistance	6.5 cm
B5	Improved balance	Creamy texture	6.8 cm

4. Washability:

Table 5: Washability Evaluation

Batch	Formulation Nature	Water Interaction	Residue After Washing	Skin Feel After Wash
B1	High cocoa butter	Slow removal	Noticeable residue	Slight greasiness

B2	Moderately hard	Partial removal	Mild residue	Slight oily feel
B3	Optimized lipid balance	Very good removal	Negligible residue	Clean, non-greasy finish
B4	Slightly firm but oily	Moderate removal	Some residue	Mild greasy feel
B5	Creamy balanced system	Good removal	Very little residue	Smooth skin feel

5. Melting Point:

Table 6: Melting Point Evaluation

Batch	Formulation Trend	Softening Point (°C)	Complete Melting Point (°C)
B1	High cocoa butter	33–34°C	37–38°C
B2	Slightly reduced hardness	32–33°C	36–37°C
B3	Optimized lipid matrix	28–29°C	32–33°C
B4	Slightly firmer system	30–31°C	34–35°C
B5	Improved balance	30–31°C	34–35°C

6. Absorption Test:

Table 7: Absorption Test

Batch	Formulation Characteristics	Water Uptake (%)	Absorption Behavior
B1	High cocoa butter content	20	Moderate
B2	Slightly increased shea butter	22	Moderate–Good
B3	Balanced lipid composition	30	Good
B4	Higher shea butter content	27	Good
B5	Equal shea and cocoa butter ratio	28	Good

7. PH Test:

Table 8: pH Evaluation

Batch	Formulation Trend	pH
B1	High solid fat	5.5
B2	Balanced start	5.4
B3	Optimized formulation	6.3
B4	Slightly firm system	5.3
B5	Improved balance	5.3

8. Acid Value:

Table 9: Acid Value Determination

Batch	Formulation Trend	Acid value
B1	High solid fat	2.7
B2	Moderately balanced	2.6
B3	Optimized formulation	1.9
B4	Slightly firm system	2.4
B5	Improved lipid balance	2.4

9. Microbial Growth:

Table 10: Microbial Growth Evaluation

Batch	Day 3 Observation	Day 7 Observation
B1	Very few spots	Few colonies visible
B2	No visible growth	Very few colonies
B3	No visible growth	No significant growth observed
B4	Few spots visible	Moderate colonies observed
B5	No visible growth	Minimal trace growth

10. SPF Determination: Detailed UV spectrophotometric analysis was performed on the optimized formulation (Batch B3) and the SPF was calculated using the Mansur equation**.**

Table 11: SPF Determination

Wavelength (nm)	Absorbance (Abs)	EE×I	Product (EE×I×Abs)
290	0.62	0.0150	0.00930
295	0.70	0.0817	0.05719
300	0.96	0.2874	0.27590
305	1.02	0.3278	0.33436
310	0.90	0.1864	0.16776
315	0.76	0.0837	0.06361
320	0.58	0.0180	0.01044
Sum			0.91856

$$\boldsymbol{SPF = CF \times \sum EE(\lambda) \times I(\lambda) \times Abs(\lambda)}$$

Where:

1. CF (Correction Factor) = 10
2. $EE(\lambda) \times I(\lambda)$ = Erythemal effect spectrum multiplied by the solar intensity spectrum (standard constants).
3. $Abs(\lambda)$ = Absorbance of the sample at wavelength λ

$$SPF = 10 \times 0.91856$$

$$SPF \approx 9.19$$

Table 11: SPF values

Batch	UV Absorption Profile	Calculated SPF
B1	Slight increase in absorbance	6.4
B2	Moderate absorbance	7.2
B3	Optimal dispersion of actives	9.19
B4	Slightly uneven distribution	8.3
B5	Better phytochemical dispersion	8.7

11. Stability Studies:

Table 12: Stability Studies

Batch	Stability Outcome (25°C & 4°C)	Observation
B1	Poor–Moderate	Slight phase separation, low hardness
B2	Moderate	Better structure but mild oiliness
B3	Excellent (Optimized)	No phase separation, ideal texture, best spreadability

B4	Good	Balanced consistency, minor softening at 25°C
B5	Moderate–Poor	Over-hardening / oil imbalance

DISCUSSION:

The results demonstrated that the ratio of shea butter and cocoa butter significantly influenced the physicochemical properties of the formulations. Batch B3 exhibited superior spreadability, stability, and sensory characteristics due to its balanced lipid composition. The presence of raspberry seed oil, aloe vera gel, and essential oils contributed to the moisturizing, antioxidant, and photoprotective properties of the formulation. The SPF value obtained for B3 further supports its potential as a natural sunscreen body butter.

LIMITATIONS:

The study was limited to short-term stability testing and in vitro SPF determination. Further long-term stability studies and in vivo photoprotective evaluations are required to confirm efficacy and shelf-life.

CONCLUSION:

The present study successfully formulated and evaluated an herbal sunscreen body butter using natural ingredients such as shea butter, cocoa butter, raspberry seed oil, aloe vera gel, olive oil, and essential oils. The results demonstrated that the ratio of shea butter to cocoa butter significantly influenced the physicochemical properties of the formulations. Among all batches, Batch B3 showed the most desirable characteristics, including excellent appearance, superior spreadability (7.8 cm), good washability, acceptable pH (6.3), low acid value (1.9), and excellent stability. The optimized ratio provided a balanced texture that was easy to apply while maintaining adequate consistency. The photoprotective potential of Batch B3 was confirmed through in vitro SPF determination using the Mansur spectrophotometric method, which yielded an SPF value of 9.19. This activity may be attributed to the presence of raspberry seed oil, which contains antioxidant compounds such as tocopherols and polyphenols. Furthermore, aloe vera and essential oils may provide additional antioxidant and skin-soothing benefits. Stability studies conducted at room and refrigerated temperatures revealed no phase separation or significant changes in texture, indicating good physical stability. Overall, the findings suggest that Batch B3 possesses desirable cosmetic, physicochemical, and photoprotective properties, making it a promising natural alternative for daily skin care and sun protection.

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CONFLICT OF INTEREST: NONE.

REFERENCES

1. Burdock, G. A. (2016). Fenaroli's handbook of flavor ingredients. CRC press.
2. Honfo, F. G., Akissoe, N., Linnemann, A. R., Soumanou, M., & Van Boekel, M. A. (2014). Nutritional composition of shea products and chemical properties of shea butter: a review. Critical reviews in food science and nutrition, 54(5), 673-686.
3. Lin, T. K., Zhong, L., & Santiago, J. L. (2018). Anti-inflammatory and skin barrier repair effects of topical application of some plant oils. International journal of molecular sciences, 19(1), 70.
4. Moldovan, M. L., Ionuț, I. U. L. I. A., & Bogdan, C. Ă. T. Ă. L. I. N. A. (2021). Cosmetic products containing natural based emollients for restoring impaired skin barrier: formulation and in vivo evaluation. Farmacia, 69(1), 129-134.
5. Thring, T. S., Hili, P., & Naughton, D. P. (2009). Anti-collagenase, anti-elastase and anti-oxidant activities of extracts from 21 plants. BMC complementary and alternative medicine, 9(1), 27.
6. Korać, R. R., & Khambholja, K. M. (2011). Potential of herbs in skin protection from ultraviolet radiation. Pharmacognosy reviews, 5(10), 164.
7. Pandel, R., Poljšak, B., Godic, A., & Dahmane, R. (2013). Skin photoaging and the role of antioxidants in its prevention. International Scholarly Research Notices, 2013(1), 930164.

8. Gad, H. A., Roberts, A., Hamzi, S. H., Gad, H. A., Touiss, I., Altyar, A. E., ... & Ashour, M. L. (2021). Jojoba oil: an updated comprehensive review on chemistry, pharmaceutical uses, and toxicity. Polymers, 13(11), 1711.
9. Parry, J., & Yu, L. (2004). Fatty acid content and antioxidant properties of cold-pressed black raspberry seed oil and meal. Journal of Food Science, 69(3), FCT189-FCT193.
10. Bergfeld, W. F., Belsito, D. V., Marks Jr, J. G., & Andersen, F. A. (2005). Safety of ingredients used in cosmetics. Journal of the American Academy of Dermatology, 52(1), 125-132.
11. Mottram, F. J., Lees, C. E., & Butler, H. (2000). Poucher's Perfumes, Cosmetics and Soaps.
12. Barel, A. O., Paye, M., & Maibach, H. I. (2001). Cosmetic Science and Technology.
13. Yuliawati, A. N., & Cahyadi, K. D. (2020). Formulation, physical quality evaluation, and antioxidant activity of body butter of ethanol extract of dragon fruit (hylocereus polyrhizus) peel. Majalah Obat Tradisional, 25(3), 146-153.
14. Bijauliya, R. K., Alok, S., Kumar, M., Chanchal, D. K., & Yadav, S. (2017). A comprehensive review on herbal cosmetics. International Journal of Pharmaceutical Sciences and Research, 8(12), 4930-4949.
15. Kushare, V. N., Ghotekar, M. D., Mande, K. S., & Kabra, P. S. (2023). Review of Herbal Formulations. World J. Pharm. Res, 12.
16. Ispiryan, A., Viškelis, J., & Viškelis, P. (2021). Red raspberry (Rubus idaeus L.) seed oil: A review. Plants, 10(5), 944.
17. Moharram, H., Ray, J., Ozbas, S., Juliani, H., & Simon, J. (2006). Shea butter: Chemistry, quality, and new market potentials.
18. Khairan, K. Evaluation of Physical Quality of Patchouli Oil (Pogostemon cablin Benth.) Body Butter Formulation. Journal of Patchouli and Essential Oil Products. Vol. 1, No.1, June 2022
19. Kumar, R., Singh, A. K., Gupta, A., Bishayee, A., & Pandey, A. K. (2019). Therapeutic potential of Aloe vera—A miracle gift of nature. Phytomedicine, 60, 152996.
20. Azhari, H., Ng, S. F., Mohd Razali, R., & Loo, H. L. (2024). The use of essential oils in atopic dermatitis: a review. Current Medical Research and Opinion, 40(5), 753-763.
21. Patil, M., Joshi, M., Kadam, J., Zambare, V., Sinha, S., Pawar, R., ... & Dhawal, P. P. (2022). Application as cosmetic bioactives of phytochemicals extracted from the post distillation biomass of geranium. Songklanakarin Journal of Science & Technology, 44(5).
22. Wongwad, E., Preedalikit, W., Rungsang, T., Srivilai, J., Aunsri, N., & Mungmai, L. (2025). Evaluation of industrial crop emollients from perilla oil, cocoa butter, and wild almond butter extracts: Physicochemical characterization, stability, bioactivity, and clinical efficacy of product formulations in a double-blind trial. Industrial Crops and Products, 236.

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