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Assessing Techniques for Creating Skin Damage and Evaluating Wound Healing: Significance for Skincare and Clinical Application

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Abstract

Background: Skin, our body's crucial barrier, faces threats and requires maintenance. Controlled skin damage induced by Sodium Lauryl Sulphate (SLS) and tape-stripping provide insights into wound creation processes. Parameters like skin hydration, topography and inflammation are vital indicators. This study validates methods for wound creation / damaging skin and evaluates product effectiveness to enhance skin health interventions.

Methods: The study adhered to ethical guidelines, receiving approval from ethics committee, and followed international and national standards, including ICH E6 (R2), and New Drugs and Clinical Trials Rules, 2019. Skin damage/wounds were induced on subjects' forearms using 1% and 3% SLS solutions and tape stripping procedure. Evaluation parameters included skin hydration, Trans-epidermal Water Loss (TEWL), surface topography, and dermatological assessment. Statistical analyses were performed using SPSS software (Version 29.0.1.0).

Results: In this study, 5 subjects with various skin types underwent controlled induced skin damage using three techniques: 1% SLS, 3% SLS, and Tape Stripping, resulting in 120 sites.TEWLincreased post-wound creation, with tape stripping showing the highest increase. Skin hydration decreased across groups, notably in the 1% SLS group. Dermatological assessments revealed increased irritation, dryness, and scaling, particularly with 3% SLS. Assessments of wound healing products demonstrated a positive trend in skin barrier repair, with Product C showing potential in retaining skin hydration. Significant improvements in skin roughness, dryness, and wrinkles were observed, with Product A exhibiting the most pronounced reductions. Overall, tape stripping appeared more effective for TEWL, while 1% SLS showed better results for skin hydration, roughness, and wrinkles.

Conclusions: This study elucidates the efficacy of various controlled skin damage techniques and wound healing products in promoting skin barrier repair and wound healing. The findings highlight the diverse effects of different wound creation methods, with tape stripping proving more effective for TEWL, while 1% SLS demonstrated outcomes at par with 3% SLS while limiting the risk of excess skin damage – in terms of skin hydration, roughness, and wrinkles. Products A, B, and C exhibited promising results in facilitating wound healing, with Product A showing the most significant improvements in skin parameters. This insight underscores the importance of tailored skin damage techniques and establishes a validated process for evaluating interventions in optimizing skin health and barrier function. Further validation and exploration of identified techniques and products hold potential to enhance skin health and wound healing outcomes.

Keywords: Skin Barrier Repair, Wound Healing, Skin Damage, Sodium Lauryl Sulphate, Tape Stripping.

Introduction

The skin, being the largest organ of the human body, plays a pivotal role in protecting the internal environment from external threats. Its multifaceted functions, particularly those related to barrier properties, are crucial for maintaining homeostasis. The skin barrier, composed of the stratum corneum, is responsible for regulating water content, preventing pathogen entry, and protecting against environmental factors. Maintaining the integrity of this barrier is vital for overall skin health.[1,2]

In the pursuit of understanding skin responses and evaluating therapeutic interventions, controlled creation of wounds is imperative. Sodium Lauryl Sulphate (SLS), a well-established skin irritant, was chosen for its ability to induce controlled skin damage. Its documented irritant properties make it a valuable tool for studying wound healing responses. By carefully manipulating the concentration and exposure, researchers can create standardized wounds, enabling reproducible assessments of healing efficacy. SLS acts by disrupting the lipid bilayer of the stratum corneum, leading to increased permeability and loss of barrier function. This controlled damage mimics various aspects of natural wound healing processes, providing valuable insights into product efficacy.[3]

Tape stripping is also a widely utilized method in research for inducing controlled skin damage. This non-invasive technique involves the repetitive application and removal of adhesive tape to the skin, effectively stripping away layers of the stratum corneum. By disrupting the skin barrier, tape stripping facilitates substance penetration, making it ideal for studying skin absorption and permeation. Additionally, it complements other wound creation methods, providing versatility for evaluating therapeutic interventions. Tape stripping has been instrumental in studying topical treatments' effects on skin healing and assessing transdermal drug delivery systems.[4,5]

The process of skin damage using SLS and tape-stripping impacts key parameters reflective of skin health. Skin hydration, inflammation, and Trans-Epidermal Water Loss (TEWL) collectively play a pivotal role in influencing the overall assessment of skin barrier function. Skin hydration is essential for maintaining flexibility, inflammation reflects the body's response to injury, and TEWL gauges the effectiveness of the skin barrier in preventing water loss. These parameters serve as quantitative indicators, offering insights into the dynamic effects of the applied interventions on the skin.[6]

This study aimed to build upon existing knowledge by validating controlled methods of wound creation using SLS and tape-stripping techniques. The efficacy of various products was evaluated based on parameters such as skin hydration, TEWL, and surface topography (roughness, dryness, wrinkles, and smoothness). By refining these processes and contributing valuable insights into wound healing mechanisms, this research endeavoured to advance the field of dermatology and enhance clinical interventions for skin health and barrier function repair.

Methods

Ethical conduct of the study

The research meticulously adhered to the ethical standards and regulations outlined by relevant federal government codes, acts, and guidelines, including the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH) guidance E6 (R2) on 'Good Clinical Practice,' as well as guidelines from the Declaration of Helsinki, Indian Council of Medical Research (ICMR), and New Drugs and Clinical Trials Rules, 2019. The study received ethical clearance from an independent ethics committee, covering all necessary documentation.

Furthermore, this clinical study was registered with ClinicalTrials.gov (NCT06379516) and the Clinical Trial Registry of India. This comprehensive ethical framework ensures the study's compliance with international and national ethical standards, safeguarding the rights, safety, and well-being of all participating subjects.

Study Design

The study comprised two phases: initially for inducing skin damage, followed by the application of products for wound healing or skin damage repair.

Subject Selection Criteria

In this study, individuals aged between 18 and 45 years, exhibiting good general health as per recent medical history, and lacking any previous adverse skin conditions or medications that might affect the study results were considered. Notably, inclusion aimed for a comprehensive range of skin types, including normal, dry, oily, and combination, to ensure the study's findings are reflective of varied dermatological profiles. The study staff voluntarily participated as subjects, reflecting their dedication to advancing dermatological research and enhancing the integrity of the study's findings.

Subjects were excluded from participation if they had a documented history of allergies or specific adverse reactions linked to the use of dermatological or cosmetic products, aiming to ensure subject safety and maintain study integrity.

Controlled Skin Damage Induction

The study involved a meticulous process of wound creation on the forearms of subjects, treating each individual arm as a separate observation unit. To standardize the process, 12 sites of $1cm^2$ (1x1cm) were marked on each arm after thorough site cleaning. These sites were further categorized into three zones, each representing a different method of wound creation: 1%w/v and 3%w/v SLS solutions, and 24times tape stripping. This resulted in four out of 12 sites allocated to each method.

The process involved the application of patches on clean, dry, intact, and healthy skin. Patches were strictly placed on sites devoid of cuts, scratches, tattoos, scars, birthmarks, and abrasions. Using hypoallergenic tape, the patches were secured for 24 hours. Additionally, a 24-time tape stripping procedure, following the established method by J. Lademann, was executed. The patches carefully were removed 24 hours later, and the test application sites were marked again using dermal markers. Following the initial assessment, new patches were applied to the same sites, and 24-time tape stripping was repeated. Later, a subsequent skin assessment was conducted at 48 hours from the first patch application.

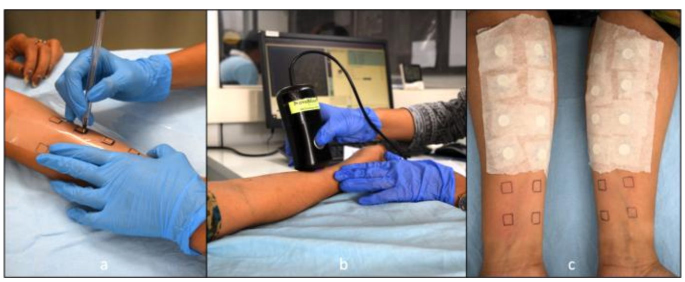

Figure 1: Visit 01 Process Photographs – (a) Site Marking Process (b) Instrumental Evaluation using Visioscan® VC20 plus (c) Post Patch Application and Tape-stripping.

Test Product Application and Evaluation Parameters

A total of three test products (A, B, and C) were applied across each type of wound creation, with an untreated site (D) serving as a control for each method. Assessments of skin after test product application involved the comprehensive analysis of all skin parameters to gauge their effects on the wounds.

A comprehensive evaluation of skin parameters was conducted at each marked site throughout the study, encompassing various measurements. The evaluation parameters included Trans Epidermal Water Loss (TEWL) measurement measured using Tewameter® TM 300, skin hydration levels measuring using Corneometer® CM 825, skin surface topography encompassing Skin Roughness, Dryness, Wrinkles, and Smoothness using Visioscan® VC20 plus, visual assessment using the Draize scale, and photographic documentation. These assessments were conducted at specific time-points. These efficacy endpoints were crucial in evaluating the impact of the wound-creation techniques by quantification of skin damage, and further providing valuable insights into product efficacy and overall skin condition throughout the study period.

Visit 01 (Day -02) included baseline scoring, instrument evaluations, and patch applications; Visit 02 (Day -01) for patch removal, irritation scoring, instrument evaluations, and patch re-applications; Visit 03 (Day 01) for patch removal, irritation scoring, instrument evaluations, and product application to the sites, with instrument evaluations post-dose at 8 hours. Further, Visit 04 (Day 02, 24 hours post-dose) for irritation scoring and instrument evaluations; Visit 05 (Day 05), Visit 06 (Day 08), and Visit 07 (Day 28, end-of-study visit) for irritation scoring and instrument evaluations.

Statistical Analysis

A preliminary statistical analysis was conducted using the data collected on Day 08, followed by a comprehensive analysis upon completion of the study on Day 28, with a specific focus on assessing skin barrier repair outcomes.

Descriptive statistics were utilized to characterize continuous variables, including the count (N), mean, standard deviation (SD), median, minimum, and maximum values for the test products. Categorical variables were presented through frequency and percentage, accompanied by graphical representations when necessary. Paired t-tests or Wilcoxon signed-rank tests were employed to analyse changes within different groups over various time points. Utilizing SPSS software (Version 29.0.1.0), ensuring a 5% level of significance.

Test Products

The test products utilized in this study, Product A and Product B, were moisturizers specifically formulated to aid in wound healing, and Product C was Coconut Oil. Applied across each type of wound creation, these products were selected for their known moisturizing properties and potential to promote skin repair and regeneration. Through comprehensive analysis of skin parameters, the study aimed to evaluate their efficacy in enhancing skin hydration, restoring barrier function, and facilitating the healing process.

Table 1: Test Product Details

	Test Product A	Test Product B	Test Product C
Product Name	Moisturizing Cream A	Moisturizing Cream B	Parachute Coconut Oil
Dosage Form	Cream	Cream	Oil
Route of Administration	Topical	Topical	Topical
Dosage	40mg / pea-sized	40mg / pea-sized	1-2ml

Study Disposition

A total of 5 subjects participated in the study. Each subject had 12 sites marked to induce skin damage, resulting in 24 sites per subject. Among the subjects, one had dry skin type, two had oily skin type, and two had combination skin type. There were no withdrawals from the study.

Results

In this study, the arms of 5 subjects were used to develop wounds on predetermined sites (12 sites per each arm of subject), giving a total of120 sites – of which 40 each were created using 1% SLS, 3% SLS, and Tape Stripping respectively. The subjects were chosen to represent all – dry, oily, and combination skin types.

Assessment of Wound Creation Techniques

Trans-epidermal water loss (TEWL) measurements were obtained for three skin damage techniques—1% SLS, 3% SLS, and tape stripping. At baseline (Visit 1), the mean TEWL values were 8.87 g/m²/h for 1% SLS, 9.25 g/m²/h for 3% SLS, and 10.22 g/m²/h for 24-times tape stripping. Subsequent visit for post-wound creation measurements at Visit 2 showed significant increases in TEWL for all techniques (p-values < 0.0001). The trend continued at Visit 3, with further increases in TEWL observed: 14.74 g/m²/h for 1% SLS, 15.13 g/m²/h for 3% SLS, and 18.14 g/m²/h for 24-times tape stripping (p-value < 0.0001). Comparison across techniques revealed that tape stripping resulted in the highest increase in TEWL i.e. 7.92 g/m²/h (83.62% increase), followed by similar increases in 3% SLS (5.88 g/m²/h) and then 1% SLS (5.87 g/m²/h).

Skin hydration appeared to have decreased across all groups at visit 02 (post wound creation) compared to baseline. The decrease appeared to be most pronounced in the 1% SLS group with a mean decrease of 6.91 units (32.30% reduction) from baseline (p-value < 0.0001). The 3% SLS group showed a mean decrease of 3.84 units (p-value < 0.0001), while 24-times tape stripping group showed a negligible decrease of 1.32 units from baseline. Refer Table 2.

The tape-stripping method demonstrated greater efficacy in reducing TEWL compared to other methods, yet it did not significantly affect skin hydration. This discrepancy may stem from the fact that tape-stripped sites remained exposed to the environment post-wound creation, whereas SLS-treated sites were covered by patches. Furthermore, there was no significant difference observed between the 1% and 3% SLS groups regarding TEWL increase. Moreover, the 1% SLS group exhibited a greater loss of skin hydration compared to the 3% SLS group, indicating that higher SLS concentrations did not confer additional benefits.

Table 2: Change in TEWL and Skin Hydration across the visits

Wound Creation			
	Visit 01 (x̄ ± SD)	Visit 02 (x̄ ± SD)	Visit 03 (x̄ ± SD)
Trans-epidermal Water Loss (TEWL) measured by Tewameter® TM 300 (g/m²/h)			
1% SLS	8.87 ± 1.64	11.34 ± 3.45	14.74 ± 4.83
3% SLS	9.25 ± 1.41	12.16 ± 5.16	15.13 ± 7.73
TS	10.22 ± 2.27	13.57 ± 5.52	18.14 ± 6.63
Skin Hydration measured by Corneometer® CM 825 (%)			
1% SLS	21.6 ± 4.06	20.81 ± 13.54	14.69 ± 8.63
3% SLS	22.12 ± 3.9	19.09 ± 7.6	18.28 ± 8.12
TS	21.09 ± 4.79	28.64 ± 20.18	19.77 ± 7.92

Wound Healing					
	Visit 03 (x̄ ± SD)	Visit 04 (x̄ ± SD)	Visit 05 (x̄ ± SD)	Visit 06 (x̄ ± SD)	Visit 07 (x̄ ± SD)
Trans-epidermal Water Loss (TEWL) measured by Tewameter® TM 300 (g/m²/h)					
A	15.45 ± 6.32	12.73 ± 4.81	12.46 ± 4.85	12.27 ± 4.64	12.32 ± 5.04
B	17.33 ± 9.32	13.51 ± 4.46	13.52 ± 4.54	13.14 ± 4.85	12.68 ± 5.46
C	14.81 ± 4.48	12.61 ± 3.85	12.47 ± 3.91	12.3 ± 3.97	12.4 ± 4.27
D	16.43 ± 5.45	13.95 ± 4.5	13.85 ± 4.69	13.38 ± 4.92	13.05 ± 5.17
Skin Hydration measured by Corneometer® CM 825 (%)					
A	17.55 ± 8.92	15.14 ± 6.98	14.32 ± 6.62	14.65 ± 7.32	15.04 ± 8.08
B	16.34 ± 7.42	13.53 ± 6.04	13.86 ± 6.23	14.2 ± 6.85	14.45 ± 7.73
C	18.69 ± 9.53	16.54 ± 7.2	15.71 ± 6.77	15.62 ± 7.06	16.02 ± 7.81
D	17.76 ± 7.97	14.09 ± 5.34	14.11 ± 5.27	13.81 ± 5.69	14.32 ± 6.37

Skin topography was evaluated across various visits in terms of roughness (SEr), dryness (SEsc), wrinkles (SEw), and smoothness (SEsm). Skin roughness, inferred from a decrease in the SE_r value, demonstrated the tape-stripping method to be the most effective in increasing roughness by 49.76% (p-value < 0.005) at Visit 03 compared to baseline. All groups exhibited a decrease in skin dryness at Visit 02, a trend that persisted at Visit 03.

The SLS groups showed higher changes in dryness, with a 628% rise for 1% SLS (p-value < 0.0001) and a 608% rise for 3% SLS (p-value < 0.0001), compared to the tape-stripping group's 400% rise (p-value < 0.05).

The tape-stripping group exhibited a 17.32% decrease in skin wrinkles (p-value < 0.0001), contrasting with a 46.11% increase in the 1% SLS group and a negligible 3.80% increase in the 3% SLS group. Additionally, skin smoothness, interpreted by the decrease in the SE_{sm} value measured by Visioscan® VC20 plus, decreased by 12.31% in the 1% SLS group (p-value < 0.05), 11.47% in the 3% SLS group (p-value > 0.05), and increased by 6.92% in the tape-stripping method (p-value < 0.05). These findings underscore the divergent effects of the various skin damage techniques: tape stripping resulted in drier, smoother skin, while SLS application led to increased wrinkling. Furthermore, consistent with the TEWL and hydration findings, the 3% SLS group did not demonstrate any incremental benefits in wound creation compared to the 1% SLS group. Refer Figure 2.

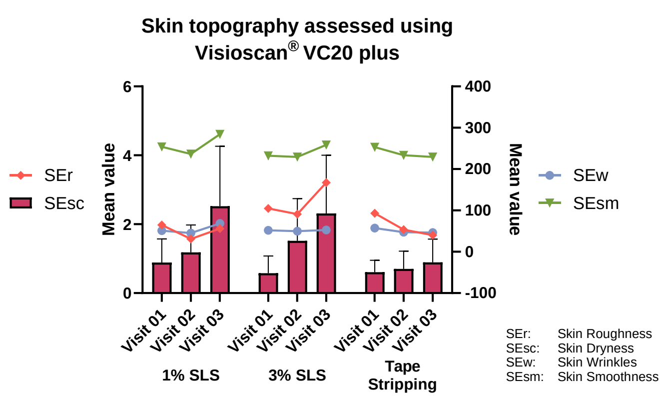

Figure 2: Skin topography assessed using Visioscan® VC20 plus for Skin Damage Evaluation

Dermatological assessments at Visits 02 and 03 revealed significant increases in irritation, dryness, scaling, itching, and swelling following wound creation, compared to baseline measurements. Particularly, the 3% SLS technique elicited the most pronounced changes in these parameters, indicating substantial skin disruption. Conversely, tape stripping induced the least irritation and dryness but did cause some scaling and itching. Notably, smoothness scores remained high for tape stripping while decreasing for both SLS techniques, underscoring the varying effects of different skin damage methods on dermatological parameters. Figure 3 illustrates the progression of skin damage over a three-day period.

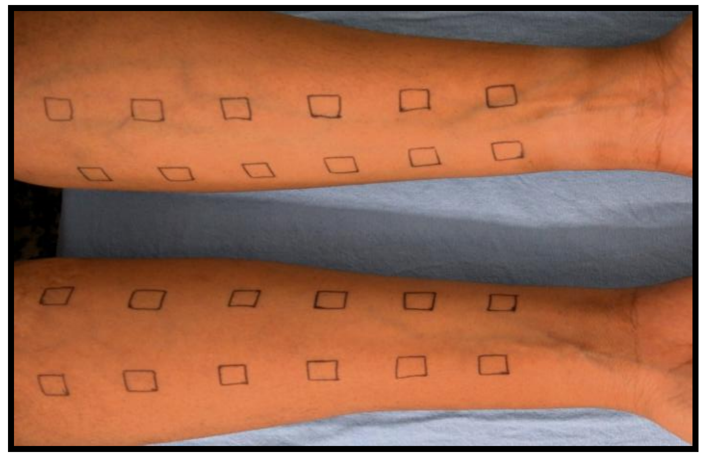

Figure 3: Skin Damage Process – Visit 01 [Baseline]

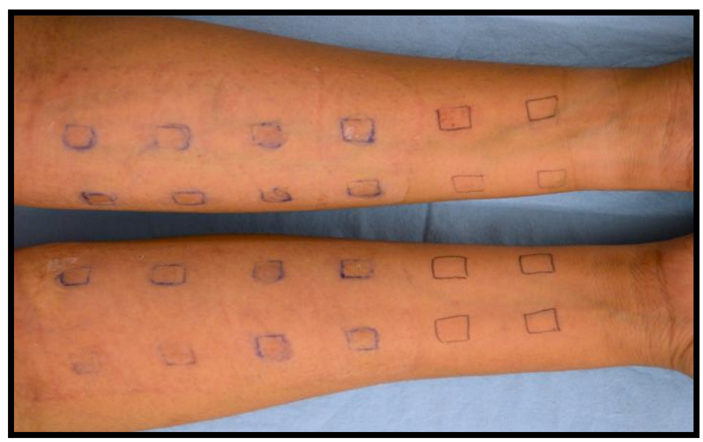

Figure 4: Skin Damage Process – Visit 02 [post 24-hours]

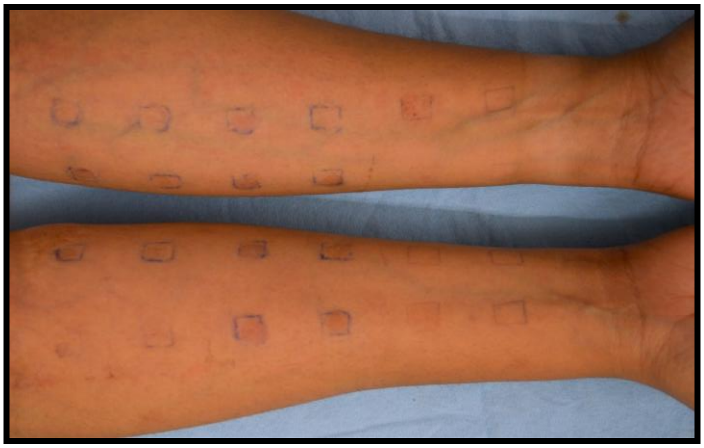

Figure 5: Skin Damage Process – Visit 03 [post 48-hours]

Assessment of Wound Healing Products

The data analysis revealed a consistent positive trend in wound healing across all four types of sites (A, B, C, and D) based on TEWL measurements. Between Visit 3 (considered as the baseline), and Visit 7, a decrease in TEWL was observed, with Product B showing the greatest reduction by 19.13% (p-value < 0.05). However, the untreated site also exhibited a decrease of 18.48% (p-value < 0.05), suggesting that the moisturizing effect of the test products was not effective in lowering TEWL. Upon examination at Visit 7, Product C emerged as potentially the most successful in retaining skin hydration, with wounds showing further reductions in hydration across all visits compared to the untreated site. Product C demonstrated 87.87% more retention in skin hydration, followed by Product A (79.26%) and Product B (57.56%).

In terms of skin barrier repair, subsequent visits (Visit 4, 5, 6, and 7) for each product revealed improvements in skin roughness, dryness, and wrinkles. Product A exhibited a reduction of 110.67% in skin roughness (p-value < 0.005), followed by Product C (66.93%, p-value < 0.0005), Product B (30.22%), with the untreated site showing a natural improvement of 25.21%. Although an increase in skin dryness was observed across all sites 8 hours post-product application, consistent reduction occurred until Visit 07, with Product A exhibiting the most improvement. For skin wrinkle, Products A and B showed the most reduction in mean values of SEw. Interpreting the skin smoothness (SEsm) however, became challenging due to the varied response across different wound types. Overall, the data suggests that all three products to be effective in wound healing, as evidenced by reductions in skin roughness, dryness, and wrinkles over time. Refer Figure 2.

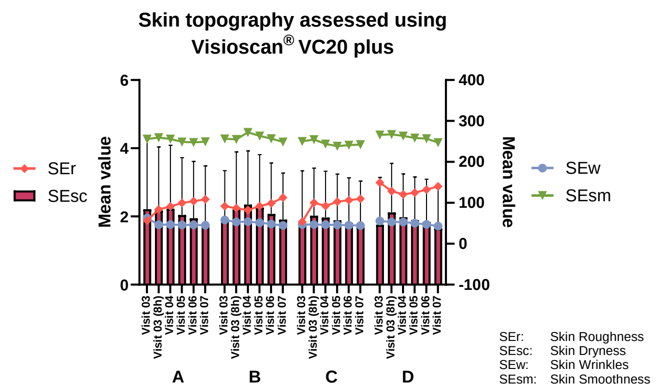

Figure 6: Skin topography assessed using Visioscan® VC20 plus for Skin Barrier Repair Evaluation

The dermatological assessment revealed a promising trend in wound healing across all products (A, B, C, D), with improvements observed in various parameters including Irritation, Dryness, Scaling, Itching, Swelling, and Smoothness over the course of multiple visits. Scores for these parameters show a decrease over time, indicating an amelioration in wound healing processes for all products. By Visit 6 and 7, scores for most parameters approach zero, implying substantial healing progress and suggesting that all products were effective to some extent in promoting wound healing.

These findings underscore the potential efficacy of Products A, B, and C, in facilitating wound healing and emphasize the importance of continued monitoring and investigation to fully understand their therapeutic benefits and mechanisms of action. Product A exhibited the most significant reductions in skin roughness and dryness, highlighting its efficacy in enhancing barrier integrity. Moreover, a marked retention of skin hydration was observed too, emphasizing its role in fortifying the skin barrier and promoting optimal hydration levels. These findings underscore the effectiveness of Product A in facilitating skin barrier repair, emphasizing its potential assistance in restoring and maintaining skin health.

Discussion

The results demonstrate distinct effects of the three skin damage techniques—1% SLS, 3% SLS, and tape stripping—on skin physiology. Trans-epidermal water loss (TEWL) measurements indicated that all techniques led to increased skin barrier disruption, with tape stripping inducing the highest TEWL followed by 3% SLS and 1% SLS. This aligns with previous research indicating the disruptive nature of SLS on the skin barrier and emphasizes the importance of considering the concentration of SLS in skincare formulations.[7]

Skin hydration, roughness, dryness, wrinkle, and smoothness were significantly altered following wound creation, with varying degrees of severity across the techniques. Interestingly, while all techniques resulted in decreased skin hydration and increased dryness, the extent of these changes differed, with the 1% SLS group exhibiting the most pronounced decrease in hydration. Similarly, tape stripping led to the lowest skin roughness and wrinkle scores compared to SLS groups, suggesting a potentially less abrasive effect on the skin surface.The 1% SLS group exhibited greater skin hydration loss than the 3% SLS group. Additionally, the 3% SLS group did not demonstrate any incremental benefits in skin damage in terms of skin topographical parameters compared to the 1% SLS group. This suggests the possibility of minimizing the risk of severe skin damage by reducing the concentration while still achieving comparable results.[8,9]

Dermatological assessments revealed that 3% SLS caused the most significant irritation, dryness, scaling, itching, and swelling, indicating substantial skin disruption. In contrast, tape stripping induced relatively less irritation and dryness but still resulted in some adverse effects. These findings highlight the importance of selecting appropriate skin damage methods based on the desired level of skin disruption and the intended purpose of the study or treatment.[10]

Our study also evaluated the wound healing potential of three different products (A, B, and C) using skin hydration, TEWL, and skin topography measurements, along with dermatological assessments. Overall, all tested products demonstrated a positive trend in wound healing, as evidenced by a decrease in TEWL over time and improvements in various dermatological parameters such as irritation, dryness, scaling, itching, swelling, and smoothness.

Interestingly, upon examination of Visit 7 (Day 28), complete barrier repair of the skin was observed, suggesting a comprehensive wound healing process. This indicates the efficacy of the tested products in facilitating skin barrier repair and underscores their potential in promoting wound healing. Notably, Product C, identified as coconut oil, emerged as potentially the most successful in retaining skin hydration, with significant improvements observed compared to other products. Coconut oil has been widely studied for its wound healing properties, attributed to its anti-inflammatory, antimicrobial, and moisturizing effects. Studies have shown that coconut oil promotes collagen synthesis, accelerates wound closure, and enhances skin barrier function, making it a valuable ingredient in skincare formulations. This aligns with the growing interest in natural alternative products for wound healing, which offer promising therapeutic benefits without the potential side effects associated with synthetic compounds. Products A and B also showed promising results in enhancing hydration and facilitating wound healing. These findings suggest that the tested products, including the moisturising creams and coconut oil used, have therapeutic potential in assisting the healing process post skin damage.[11-14]

The techniques for skin damage used in this study offer researchers standardized methods to assess skin barrier function and wound healing in diverse populations. Their potential usage in clinical research ensures the safety and efficacy testing of skincare products in a controlled and reproducible manner, facilitating advancements in skincare science and the development of novel formulations. Additionally, our methodology effectively evaluated and compared the efficacies of the test products in the wound healing process. This approach facilitated the identification of promising products for further investigation, contributing to evidence-based skincare interventions and clinical research methodologies.

However, it's important to note that the efficacy of skin damage techniques and wound-healing products may vary depending on individual skin types and conditions. Further research is warranted to elucidate the mechanisms of action underlying the observed effects and to optimize the use of these techniques and products in clinical practice.

Conclusion

In conclusion, our study highlights the diverse effects of wound-creation/skin-damage techniques—1% SLS, 3% SLS, and tape stripping—on skin physiology, quantified using various assessments. Additionally, the tested products demonstrate promising wound healing potential. By establishing a validated process for evaluating wound-healing product efficacy, our study lays a solid foundation for future research in skincare and wound management. These findings advance our understanding of skin barrier function and wound healing mechanisms, offering insights for the development of effective skincare formulations and therapeutic strategies. Further validation and exploration of these techniques and products are needed to optimize skin health and wound healing outcomes, guiding improved clinical interventions in this field.

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Declarations

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Disclosure: Authors report no conflict of interest.

Ethical approval: The study was approved by an Independent Ethics Committee.

Clinical Trials.gov and CTRI registration done.

Abbreviations

SLS: Sodium Lauryl Sulphate

ICH: International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use

TEWL: Trans-epidermal Water Loss

References

1. Del Rosso J, Zeichner J, Alexis A, Cohen D, Berson D. Understanding the Epidermal Barrier in Healthy and Compromised Skin: Clinically Relevant Information for the Dermatology Practitioner. The Journal of Clinical and Aesthetic Dermatology, 9(4).
2. Wound Healing. (n.d.). Physiopedia. https://www.physio-pedia.com/Wound_Healing
3. Leoty-Okombi, S., Gillaizeau, F., Leuillet, S., Douillard, B., Le Fresne-Languille, S., Carton, T., De Martino, A., Moussou, P., Bonnaud-Rosaye, C., & André, V. (2021). Effect of Sodium Lauryl Sulfate (SLS) Applied as a Patch on Human Skin Physiology and Its Microbiota. Cosmetics, 8(1), 6. https://doi.org/10.3390/cosmetics8010006
4. Lademann, J., Jacobi, U., Surber, C., Weigmann, H. J., & Fluhr, J. W. (2009). The tape stripping procedure – evaluation of some critical parameters. European Journal of Pharmaceutics and Biopharmaceutics, 72(2), 317–323. https://doi.org/10.1016/j.ejpb.2008.08.008
5. Surber, C., Schwarb, F. P., & Smith, E. W. (2001). Tape-stripping technique. Journal of Toxicology: Cutaneous and Ocular Toxicology, 20(4), 461–474. https://doi.org/10.1081/cus-120001870
6. Jusoh, N., Ko, J., & Jeon, N. L. (2019). Microfluidics-based skin irritation test using in vitro 3D angiogenesis platform. APL Bioengineering, 3(3), 036101. https://doi.org/10.1063/1.5093975
7. Tottoli, E. M., Dorati, R., Genta, I., Chiesa, E., Pisani, S., & Conti, B. (2020). Skin Wound Healing Process and New Emerging Technologies for Skin Wound Care and Regeneration. Pharmaceutics, 12(8), 735. https://doi.org/10.3390/pharmaceutics12080735
8. Ridhanya, K., & Rajakumari. (2019). Skin Wound Healing: An update on the Current knowledge and Concepts. Research Journal of Pharmacy and Technology, 12(3), 1448. https://doi.org/10.5958/0974-360x.2019.00240.3
9. Kolimi, P., Narala, S., Nyavanandi, D., Youssef, A. A. A., & Dudhipala, N. (2022). Innovative Treatment Strategies to Accelerate Wound Healing: Trajectory and Recent Advancements. Cells, 11(15), 2439. https://doi.org/10.3390/cells11152439
10. Danks, R. (2021, June 22). Wound Closure Technique. Medscape. https://emedicine.medscape.com/article/1836438
11. Ryall, C., Duarah, S., Chen, S., Yu, H., & Wen, J. (2022). Advancements in Skin Delivery of Natural Bioactive Products for Wound Management: A Brief Review of Two Decades. Pharmaceutics, 14(5), 1072. https://doi.org/10.3390/pharmaceutics14051072
12. Moses, R. L., Prescott, T. A. K., Mas-Claret, E., Steadman, R., Moseley, R., & Sloan, A. J. (2023). Evidence for Natural Products as Alternative Wound-Healing Therapies. Biomolecules, 13(3), 444. https://doi.org/10.3390/biom13030444
13. Stan, D., Tanase, C., Avram, M., Apetrei, R., Mincu, N., Mateescu, A. L., & Stan, D. (2021). Wound healing applications of creams and “smart” hydrogels. Experimental Dermatology, 30(9), 1218–1232. https://doi.org/10.1111/exd.14396
14. Sood, A., Granick, M. S., & Tomaselli, N. L. (2014). Wound Dressings and Comparative Effectiveness Data. Advances in Wound Care, 3(8), 511–529. https://doi.org/10.1089/wound.2012.0401