FORMULATION AND EVALUATION OF CURCUMIN -LOADED ALOE VERA HERBAL CREAM USING FOR SCAR MANAGEMENT

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Abstract: Scars are areas of fibrous tissue that develop as part of the body's response to injury. Although scar formation is a normal component of wound healing, excessive or abnormal collagen deposition may produce hypertrophic scars and keloids, while insufficient tissue replacement may lead to atrophic scars. Scars can cause cosmetic concerns, itching, pain, tightness, and restriction of movement. Their development is influenced by wound depth, inflammation, infection, mechanical tension, anatomical location, and individual predisposition. This review summarises scar formation, major scar types, biological mechanisms, risk factors, prevention, and commonly used management options. It also outlines the research interest in topical and herbal preparations, including curcumin and Aloe vera, while emphasising that laboratory findings do not by themselves establish clinical effectiveness for scar treatment.

IndexTerms - Scar; wound healing; fibrosis; collagen; hypertrophic scar Aloe vera; keloid; curcumin topical formulation

1.Introduction

A scar is a mark or area of fibrous connective tissue that replaces normal tissue after skin injury, surgery, burns, inflammation, or disease. Scar formation is part of normal repair, especially when damage reaches the dermis. Scar tissue contains extracellular-matrix proteins, particularly collagen, arranged differently from uninjured skin. Consequently, a scar may have altered texture, colour, flexibility, sensation, and appendages such as hair follicles. Many scars gradually mature over months, but some remain raised, depressed, itchy, painful, or restrictive. Scar management is therefore relevant to dermatology, surgery, wound care, rehabilitation, and pharmaceutical formulation research.



2. Objectives of the Review

- To describe the stages of wound healing and the biological basis of scar formation.
- To classify common scars and explain their clinical features.
- To summarise factors associated with abnormal scarring.
- To review general prevention and available scar-management approaches.
- To discuss the research rationale for studying topical formulations containing curcumin and Aloe vera without assuming proven clinical efficacy.

3. Method of Literature Review

This is a narrative review prepared from established clinical and scientific reference sources on scar formation, wound healing, and scar treatment. It is intended as a study overview rather than a systematic review. A formal systematic review would require a documented database search, search dates, inclusion and exclusion criteria, duplicate screening, and critical appraisal of every included study. Students should verify the latest articles and bibliographic details through PubMed, Google Scholar, or their college library before submitting this review for academic assessment.

4. Biology of Wound Healing and Scar Formation

4.1 Haemostasis

Haemostasis begins immediately after injury. Blood vessels constrict and platelets aggregate to reduce bleeding. A fibrin-rich clot forms a temporary matrix that supports inflammatory and repair processes.

4.2 Inflammation

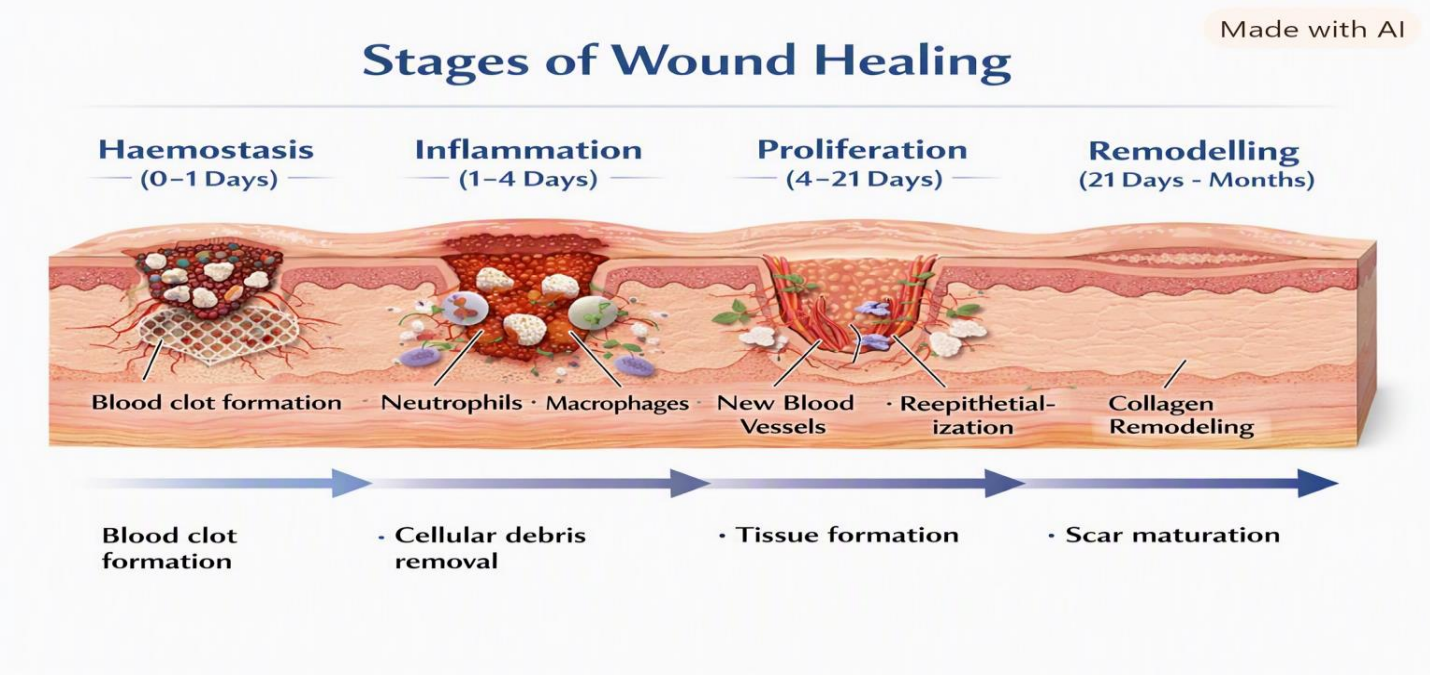
Neutrophils and macrophages help remove microorganisms, damaged cells, and debris. They also release signalling molecules that coordinate tissue repair. An appropriately regulated inflammatory response supports healing; prolonged inflammation may contribute to abnormal scar development.

4.3 Proliferation

Fibroblasts produce collagen and other extracellular-matrix components. New blood vessels form, and keratinocytes migrate to restore the skin surface. Myofibroblasts can contract the wound and help bring wound edges together.

4.4 Remodelling

During remodelling, collagen is reorganised and cross-linked, and extracellular-matrix synthesis and degradation are adjusted. The scar commonly becomes flatter, softer, and less red over time. Maturation may continue for many months. Scar tissue generally does not fully reproduce the strength, elasticity, pigmentation, or appendages of normal skin.



5. Types of Scars

5.1 Normal or fine-line scars

These often develop after uncomplicated cuts or surgical incisions. They may initially be pink or slightly raised and usually become less noticeable as they mature.

5.2 Atrophic scars

Atrophic scars are depressed because dermal collagen or supporting tissue is lost or inadequately restored. They may follow acne, chickenpox, or other inflammatory skin conditions.

5.3 Hypertrophic scars

Hypertrophic scars are raised scars that remain within the boundaries of the original wound. They reflect excessive matrix deposition and may be red, firm, itchy, or tender. Some gradually flatten with time.

5.4 Keloid scars

Keloids extend beyond the original wound margins and may continue to grow. They can occur after surgery, burns, acne, piercings, or minor injury. They may cause itching, discomfort, or pain and can recur after treatment. Clinical assessment is recommended when a keloid is suspected.

5.5 Contracture scars

Contractures occur when scar tissue tightens and pulls on surrounding skin. They are particularly important after burns and may limit movement when they cross joints or involve deeper tissues.

5.6 Stretch marks

Stretch marks, or striae, appear as linear marks after rapid stretching or changes in the skin, such as during pregnancy, puberty, or substantial weight change. They are related to changes in dermal connective tissue but are not identical to scars caused by an open wound.

6. Pathophysiology of Fibrotic Scarring

Scar formation depends on a balance between extracellular-matrix production and breakdown. Fibroblasts produce collagen and other matrix components; myofibroblasts contribute to wound contraction. Signalling pathways and growth factors, including transforming growth factor-beta (TGF-β), participate in regulating inflammation, fibroblast activity, and collagen deposition. Excessive or persistent activity in these processes may contribute to hypertrophic scars or keloids. Mechanical tension, infection, prolonged inflammation, wound depth, and individual predisposition can also affect the final scar. The biology is complex, and hypertrophic scars and keloids are related but distinct conditions.

7. Causes and Risk Factors

- Deep, large, or slow-healing wounds.
- Burns, surgery, cuts, acne, chickenpox, or skin inflammation.
- Infection or repeated irritation during healing.
- Mechanical tension on the wound, particularly at high-tension body sites.
- Personal or family history of keloids or hypertrophic scars.
- Location of the injury and individual differences in healing.

8. Clinical Features and Assessment

Scars vary in colour, thickness, texture, and shape. They may be pale, pink, red, brown, raised, flat, or depressed. Some cause itching, pain, tenderness, tightness, sensitivity, or reduced movement, while others mainly affect appearance. Assessment generally includes the history of the injury, time since healing, change over time, symptoms, body location, and history of previous abnormal scars. Unusual or changing lesions, signs of infection, worsening pain, or functional restriction warrant assessment by a qualified healthcare professional.

9. Prevention and General Care

- Follow appropriate first-aid or clinician instructions for cleaning and dressing a wound.
- Do not pick scabs or repeatedly traumatise healing skin.
- Seek medical advice if redness, warmth, swelling, pain, or discharge increases.
- After the wound has fully closed, silicone gel or silicone sheets may be considered for some raised scars, following product or clinician guidance.
- Protect healing scars from excessive sunlight to help reduce persistent colour changes.
- Follow rehabilitation advice for burns or scars that may restrict movement.

Scar prevention cannot be guaranteed because healing is affected by wound severity, anatomy, genetics, and individual biology.

10. Scar-Management Options

10.1 Silicone products

Silicone gels and sheets are commonly used for raised scars. They may help improve scar thickness, softness, or symptoms in some people, but response varies and consistent use is often required.

10.2 Pressure therapy

Pressure garments may be recommended by specialist teams, particularly for selected burn scars. Fit, duration, comfort, and suitability require professional guidance.

10.3 Corticosteroid injections

Intralesional corticosteroids may be used for hypertrophic scars and keloids to reduce inflammation and thickness. Possible adverse effects include skin thinning, pigment changes, and small visible blood vessels; treatment should be administered by trained clinicians.

10.4 Other specialist treatments

Depending on scar type, clinicians may consider laser therapy, cryotherapy, selected injections, microneedling, surgical revision, or combinations of treatments. Surgery alone may have a high recurrence risk for keloids, so it is often combined with other measures. Treatment choice should be individualised.

10.5 Topical preparations

Topical products are studied for their potential to moisturise skin, improve symptoms, or influence scar appearance. Evidence varies considerably by ingredient and scar type. Cosmetic improvement in skin hydration or colour should not be interpreted as proof that a product reverses fibrosis or prevents keloid recurrence.

11. Curcumin and Aloe vera: Relevance to Topical Formulation Research

11.1 Curcumin

Curcumin is a polyphenolic constituent of turmeric (Curcuma longa). Laboratory research has examined its antioxidant and anti-inflammatory properties and its possible effects on pathways involved in tissue repair and fibrosis. However, curcumin has limited aqueous solubility and can show stability and skin-delivery challenges. Nanoparticle systems are being investigated as a way to alter dispersion, protection, and delivery. The performance of a specific formulation must be established experimentally; findings from cell or animal studies cannot alone demonstrate that it effectively treats human scars.

11.2 Aloe vera

Aloe vera gel is widely used in topical products for its moisturising properties. Research has explored its role in skin comfort and wound care, but evidence differs by preparation and clinical outcome. Plant source, processing, concentration, storage, and microbial quality can affect the final product. Aloe vera should not be described as a proven anti-fibrotic scar treatment without suitable clinical evidence.

11.3 Rationale for combining curcumin nanoparticles and Aloe vera in a cream

A combined topical cream may be investigated as a formulation-development project because curcumin offers a research interest in inflammation-related pathways, while Aloe vera can contribute to the product's topical vehicle and moisturising properties. A project should first establish reproducible formulation quality, physical stability, pH, spreadability, viscosity, drug content, and appropriate in-vitro release. Particle size, polydispersity index, and zeta potential may be measured if a suitable nanoparticle system and instruments are available. Safety and efficacy claims require appropriate validated testing; a student formulation should not be presented as clinically proven for scar management.

12. Evaluation Parameters for a Research Formulation

- Appearance, colour, odour, homogeneity, and phase separation.
- pH and viscosity using a stated, reproducible method and instrument.
- Spreadability and extrudability, where relevant to the container.
- Drug content and content uniformity using a validated analytical method.
- In-vitro release testing with a justified membrane, medium, temperature, sampling schedule, and analytical method.
- For nanoparticles: particle size, polydispersity index (PDI), and zeta potential, using an appropriate instrument.
- Stability under defined storage conditions, with observations at planned intervals.

13. Discussion

early management of complications. Existing scar treatments may improve thickness, symptoms, appearance, or function, but results vary and complete removal is uncommon. Topical and herbal formulations are an active area of investigation; nevertheless, formulation quality, reproducible analytical testing, safety assessment, and appropriately designed clinical studies are needed before therapeutic claims can be made. For a B.Pharm project, it is academically stronger to describe curcumin nanoparticle and Aloe vera cream as a

formulation under investigation rather than as an established treatment for fibrosis. Scarring is a normal but variable outcome of tissue repair. The most important distinction in clinical management is between ordinary scars, atrophic scars, hypertrophic scars, keloids, and contractures because their behaviour and treatment options differ. Prevention focuses on good wound care and

14. Conclusion

testing alone Scars develop when injured tissue is repaired through collagen deposition and remodelling. Their appearance and symptoms depend on the type of injury, wound healing, body location, and individual factors. General wound care and suitable scar-management approaches can help reduce complications, while raised, painful, growing, or movement-limiting scars may require professional assessment. Curcumin nanoparticles and Aloe vera cream may be studied as a topical formulation concept, but its physical quality, release, safety, and anti-fibrotic effectiveness must be demonstrated through appropriate experiments. Clinical effectiveness should not be claimed from formulation.

References

1. Gurtner GC, Werner S, Barrandon Y, Longaker MT. Wound repair and regeneration. Nature. 2008;453:314–321. doi:10.1038/nature07039.
2. Rodrigues M, Kosaric N, Bonham CA, Gurtner GC. Wound healing: A cellular perspective. Physiol Rev. 2019;99(1):665–706. doi:10.1152/physrev.00067.2017.
3. Ogawa R. Keloid and hypertrophic scars are the result of chronic inflammation in the reticular dermis. Int J Mol Sci. 2017;18(3):606. doi:10.3390/ijms18030606.
4. Berman B, Maderal A, Raphael B. Keloids and hypertrophic scars: Pathophysiology, classification, and treatment. Dermatol Surg. 2017;43(Suppl 1):S3–S18. doi:10.1097/DSS.000000000007. Ansari L, Mashayekhi-Sardoo H, Rahimi VB, et al. Curcumin-based nanoformulations alleviate wounds and related disorders: A comprehensive review. Biofactors. 2023;49(4):736–781. doi:10.1002/biof.1945.
5. Kumari A, Raina N, Wahi A, et al. Wound-healing effects of curcumin and its nanoformulations: A comprehensive review. Pharmaceutics. 2022;14(11):2288. doi:10.3390/pharmaceutics14112288.
6. Salehi B, Rodrigues CF, Peron G, et al. Curcumin nanoformulations for antimicrobial and wound healing purposes. Phytother Res. 2021;35(5):2487–2499. doi:10.1002/ptr.6976.
7. Kumbhar S, Khairate R, Bhatia M, Choudhari P, Gaikwad V. Evaluation of curcumin-loaded chitosan nanoparticles for wound healing activity. ADMET DMPK. 2023;11(4):601–613. doi:10.5599/admet.1897.
8. Chelu M, Musuc AM, Popa M, Moreno JC. Aloe vera-based hydrogels for wound healing: Properties and therapeutic effects. Gels. 2023;9(7):539. doi:10.3390/gels9070539.
9. Aloe vera and wound healing: A brief review. Braz J Pharm Sci. 2022;58:e20837. doi:10.1590/s2175-97902022e20837.
10. Dat AD, Poon F, Pham KBT, Doust J. Aloe vera for treating acute and chronic wounds. Cochrane Database Syst Rev. 2021;(11):CD008762. doi:10.1002/14651858.CD008762.pub2.
11. Elsaie ML. Update on management of keloid and hypertrophic scars: A systematic review. J Cosmet Dermatol. 2021;20(9):2729–2738. doi:10.1111/jocd.14310.
12. Kim EY, Hussain A, Khachemoune A. Evidence-based management of keloids and hypertrophic scars in dermatology. Arch Dermatol Res. 2023;315(6):1487–1495. doi:10.1007/s00403-022-02509-x.
13. Barone N, Safran T, Vorstenbosch J, et al. Current advances in hypertrophic scar and keloid management. Semin Plast Surg. 2021;35(3):145–152. doi:10.1055/s-0041-1731461.
14. Davies BM, Carter AR, Brindley DA. A scoping review of the treatment of hypertrophic scars and keloids. Dermatol Rev. 2024;5:e118. doi:10.1002/der2.118.
15. Sharma S, Alfonso AR, Gordon AJ, et al. Second-degree burns and Aloe vera: A meta-analysis and systematic review. Adv Skin Wound Care. 2022;35(11):1–9. doi:10.1097/01.ASW.0000875056.29059.78.
16. Rujirachotiwat A, Suttamanatwong S. Curcumin upregulates transforming growth factor-β1, its receptors, and vascular endothelial growth factor expressions in an in vitro human gingival fibroblast wound healing model. BMC Oral Health. 2021;21:535. doi:10.1186/s12903-021-01890-9.
17. Liu C, Zhu Y, Lun X, Sheng H, Yan A. Effects of wound dressing based on the combination of silver@curcumin nanoparticles and electrospun chitosan nanofibers on wound healing. Bioengineered. 2022;13(2):4328–4339. doi:10.1080/21655979.2022.2031415.

18. Cross-linked alginate dialdehyde/chitosan hydrogel encompassing curcumin-loaded bilosomes for enhanced wound healing activity. Pharmaceutics. 2024;16(1):90. doi:10.3390/pharmaceutics16010090.
19. Padalkar R, Madgulkar A, Mate R, et al. Investigation of curcumin nanoparticles and D-panthenol for diabetic wound healing in Wistar rats: Formulation, statistical optimization and in-vivo evaluation. J Drug Deliv Sci Technol. 2024;93:105390. doi:10.1016/j.jddst.2024.105390.
20. Santonocito D, Puglia C. Lipid nanoparticles and skin: Discoveries and advances. Cosmetics. 2025;12(1):22. doi:10.3390/cosmetics12010022.
21. Mohd Shamsuddin NA, Azmi F, Husain K, Mun LL, Zulfakar MH. Design and characterisation of curcumin-loaded nanostructured lipid carriers for safe and efficient topical drug delivery in the treatment of pressure ulcer. Sains Malaysiana. 2024;53(6):1343–1362. doi:10.17576/jsm-2024-5306-10.
22. Poornima G, Deepa M, Devadharshini M, et al. In-situ synthesis and evaluation of anti-bacterial efficacy and angiogenesis of curcumin encapsulated lipogel dermal patch for wound healing applications. Biomater Adv. 2024;164:213989. doi:10.1016/j.bioadv.2024.213989.

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