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"A REVIEW ON THE WOUND-HEALING POTENTIAL AND ANALYTICAL STANDARDIZATION OF *TECOMA STANS* ETHANOLIC GEL"

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Abstract:

Wound healing is a complex biological process that becomes significantly impaired in diabetic conditions due to oxidative stress, poor circulation, and prolonged inflammation. Tecoma stans is a medicinal plant known for its antioxidant, anti-inflammatory, antimicrobial, and antidiabetic properties. This review summarizes the phytochemical composition, pharmacological activities, gel formulation approach, and analytical standardization of Tecoma stans for wound management. The presence of flavonoids, alkaloids, phenolic compounds, and naphthoquinones contributes to its therapeutic effectiveness. Incorporation of the ethanolic extract into a topical gel system enhances stability, controlled release, and patient compliance. Analytical techniques such as UV–Visible spectroscopy and HPLC ensure quality control and reproducibility. Overall, Tecoma stans shows promising potential as a standardized herbal formulation for effective diabetic wound healing.

Keywords: *Tecoma stans, wound healing, diabetic ulcers, phytochemistry, herbal gel, antioxidant activity, HPLC, UV–Visible spectroscopy, analytical standardization, topical formulation*

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1. INTRODUCTION

Wound healing is a natural process by which the body repairs damaged tissues after injury. It is a complex but well-organized process that occurs in different stages. These stages include hemostasis (control of bleeding), inflammation, proliferation, and remodeling. Immediately after injury, blood clotting occurs to stop bleeding. After that, white blood cells remove bacteria and damaged tissue. In the next stage, new tissue and blood vessels start forming, and collagen is produced to strengthen the wound. Finally, the wound matures and gains strength over time.

However, in some medical conditions like diabetes, the normal healing process becomes slow and incomplete. High blood sugar levels reduce blood circulation and increase oxidative stress in the body. This leads to poor oxygen supply to tissues, delayed collagen formation, and increased chances of infection. As a result, diabetic patients often suffer from chronic wounds or ulcers that take a long time to heal.[1]

Conventional treatments for wounds include antibiotics, antiseptic creams, and synthetic dressings. Although these treatments are helpful, they may cause side effects, irritation, or antibiotic resistance. They can also be expensive. Because of these limitations, researchers are now focusing on herbal medicines, which are considered safer and more affordable.

One such medicinal plant is Tecoma stans, commonly known as Yellow Bells. This plant contains important bioactive compounds such as flavonoids, alkaloids, and phenolic compounds. These compounds have antioxidant, anti-inflammatory, antimicrobial, and antidiabetic properties. Due to these activities, *Tecoma stans* shows strong potential in promoting wound healing, especially in diabetic conditions.[2]

Formulating the plant extract into a topical gel can improve its effectiveness by providing better contact with the wound surface and controlled release of active compounds. Therefore, scientific evaluation and proper standardization are important to ensure the safety and quality of herbal gel formulations.[3]

2. WOUND HEALING MECHANISM

Wound healing is a natural biological process that helps the body repair damaged skin and tissues. It occurs in a well-organized sequence of overlapping stages. Each stage plays an important role in restoring the structure and function of the injured area. The four main stages of wound healing are hemostasis, inflammation, proliferation, and remodeling.[4]

2.1 Hemostasis (Control of Bleeding)

Hemostasis is the first stage of wound healing and begins immediately after injury. When blood vessels are damaged, they constrict to reduce blood loss. Platelets gather at the injury site and form a blood clot. This clot acts as a temporary protective barrier and prevents excessive bleeding. It also forms a base for the migration of other cells required for healing. The clot contains fibrin, which provides structural support and helps in stabilizing the wound area.[5]

2.2 Inflammation

After bleeding is controlled, the inflammatory phase begins. In this stage, white blood cells such as neutrophils and macrophages move to the wound site. Their main function is to remove bacteria, dead tissue, and foreign particles. These immune cells release chemical substances called cytokines and growth factors, which help in controlling infection and preparing the wound for the next stage of healing. Mild redness, swelling, heat, and pain are normal signs of inflammation. However, excessive or prolonged inflammation can delay healing, especially in diabetic patients.[6]

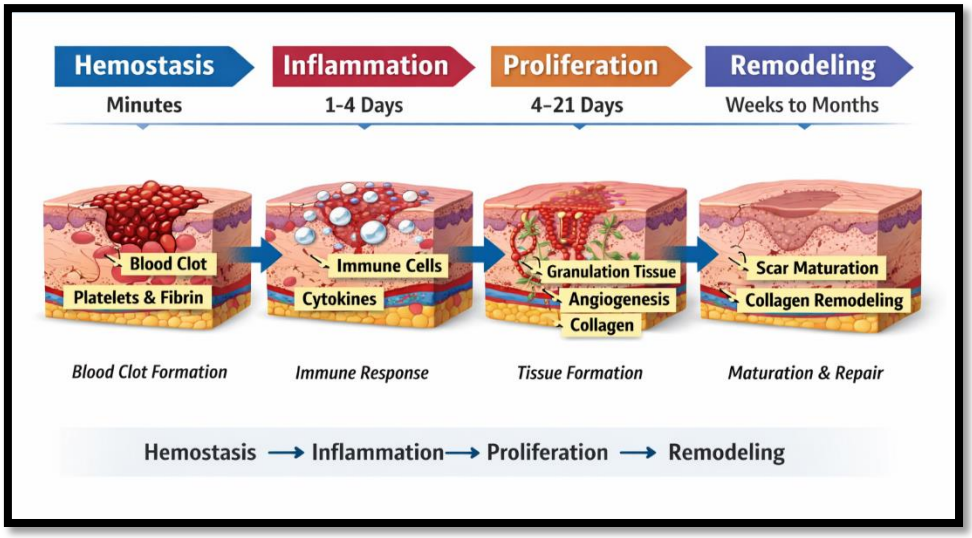

Fig. 2.1: Stages of Wound Healing – Hemostasis, Inflammation, Proliferation, and Remodeling

2.3 Proliferation (Tissue Formation)

The proliferative phase focuses on rebuilding the damaged tissue. Fibroblast cells produce collagen, which is an important protein that strengthens the wound. New blood vessels form through a process called angiogenesis, supplying oxygen and nutrients to the healing tissue. At the same time, skin cells (keratinocytes) move across the wound surface to close the wound. This process is called re-epithelialization. Granulation tissue, which is soft and pink in color, forms during this stage.[7]

2.4 Remodeling (Maturation Phase)

Remodeling is the final stage of wound healing. In this phase, the collagen fibers reorganize and become stronger. Type III collagen is gradually replaced by type I collagen, increasing the tensile strength of the healed tissue. This stage can last for several weeks or even months. Although the wound becomes stronger, it may not regain full strength like normal skin.[8]

3. DIABETIC WOUND PATHOPHYSIOLOGY

Diabetic wounds heal slowly because high blood sugar levels affect normal body functions. In diabetes, prolonged hyperglycemia damages small blood vessels, reducing blood circulation to the skin and tissues. Poor blood flow means less oxygen and fewer nutrients reach the wound site, which delays tissue repair. Oxygen is very important for collagen production and new blood vessel formation, so its deficiency slows healing.[9]

Another major problem in diabetic wounds is oxidative stress. High glucose levels increase the production of reactive oxygen species (ROS), which damage cells, proteins, and DNA. This creates an unhealthy environment at the wound site and prolongs inflammation. Normally, inflammation is a short and controlled stage, but in diabetic patients, it lasts longer and prevents proper progression to the next healing phase.[10]

Diabetes also weakens the immune system. White blood cells do not function properly, making the wound more prone to infections. Bacterial growth further delays healing and may lead to chronic ulcers. In addition, collagen synthesis is reduced, and fibroblast activity becomes weak, resulting in poor tissue strength.[11]

Because of these combined factors—poor circulation, oxidative stress, prolonged inflammation, infection risk, and reduced collagen formation—diabetic wounds often become chronic and require special therapeutic management.

4. ROLE OF *Tecoma stans* IN WOUND HEALING

The medicinal plant **Tecoma stans**, commonly known as Yellow Bells, has gained scientific attention due to its strong pharmacological properties related to wound management. Traditionally used for diabetes and skin disorders, recent research supports its potential in accelerating wound healing, especially in diabetic conditions. The therapeutic effect of *Tecoma stans* is mainly due to the presence of bioactive compounds such as flavonoids, alkaloids, phenolic acids, and naphthoquinones.[12]

4.1 Antioxidant Role

Oxidative stress is a major factor responsible for delayed wound healing. High levels of reactive oxygen species (ROS) damage tissues and prolong inflammation. *Tecoma stans* contains flavonoids like quercetin and phenolic compounds such as chlorogenic acid, which act as powerful antioxidants. These compounds neutralize free radicals and protect cells from oxidative damage. By reducing oxidative stress, the plant extract supports fibroblast activity and collagen production, leading to faster wound repair.[13]

4.2 Anti-inflammatory Activity

Inflammation is necessary in the early stage of healing, but excessive inflammation delays recovery. Extracts of *Tecoma stans* have shown the ability to reduce inflammatory mediators such as TNF-α and interleukins. This helps control swelling, redness, and pain at the wound site. By regulating inflammation, the plant promotes smooth transition from the inflammatory phase to the proliferative phase.[14]

4.3 Antimicrobial Effect

Infected wounds heal slowly and may become chronic. *Tecoma stans* has demonstrated antibacterial activity against common wound pathogens like *Staphylococcus aureus* and *Escherichia coli*. Alkaloids such as tecomine and tecostanine contribute to this antimicrobial action. This reduces infection risk and supports faster healing.[15]

4.4 Role in Collagen Formation and Tissue Regeneration

Collagen synthesis is essential for wound strength and closure. Studies show that *Tecoma stans* extract enhances fibroblast proliferation and increases collagen deposition. It also supports angiogenesis, improving oxygen and nutrient supply to the healing tissue.[16]

Table 4.1: Pharmacological Activities of *Tecoma stans* in Wound Healing

Active Compound	Pharmacological Activity	Contribution to Wound Healing
Flavonoids (Quercetin)	Antioxidant	Reduces oxidative stress and promotes collagen synthesis
Alkaloids (Tecomine)	Antimicrobial	Prevents bacterial infection
Chlorogenic acid	Anti-inflammatory	Controls swelling and cytokine release

Lapachol	Antimicrobial & regenerative	Supports tissue repair and infection control

Tecoma stans plays a multifunctional role in wound healing by reducing oxidative stress, controlling inflammation, preventing infection, and promoting tissue regeneration. These combined actions make it a promising candidate for developing effective topical formulations for diabetic wound management.[17]

5. PHYTOCHEMISTRY OF *Tecoma stans*

The therapeutic potential of **Tecoma stans** is mainly due to the presence of various bioactive chemical compounds. These natural compounds, also known as phytochemicals, are responsible for its antioxidant, anti-inflammatory, antimicrobial, and wound-healing activities. The leaves of *Tecoma stans* are especially rich in secondary metabolites, which play a major role in tissue repair and protection against infections.[18]

5.1 Major Phytochemical Classes

Phytochemical screening studies have shown that *Tecoma stans* contains several important classes of compounds:

- **Flavonoids** – These are powerful antioxidants. Compounds like quercetin and luteolin help reduce oxidative stress and support collagen formation.
- **Alkaloids** – Alkaloids such as tecomine and tecostanine are known for antimicrobial and antidiabetic properties.
- **Phenolic Compounds** – Chlorogenic acid is a major phenolic compound that reduces inflammation and protects tissues from oxidative damage.
- **Naphthoquinones** – Lapachol is an important compound with antimicrobial and regenerative properties.
- **Terpenoids and Sterols** – These contribute to anti-inflammatory and tissue repair activities.

These phytochemicals work together to promote wound contraction, enhance fibroblast proliferation, and improve angiogenesis.[19]

5.2 Important Marker Compounds

Certain compounds are considered marker compounds because they are used for identification and quality control of the plant extract:

- **Quercetin** – A flavonoid responsible for antioxidant activity.
- **Chlorogenic acid** – A phenolic compound with anti-inflammatory effects.
- **Lapachol** – A naphthoquinone with antimicrobial properties.
- **Tecomine** – An alkaloid linked to hypoglycemic activity.

These markers are often analyzed using UV–Visible spectroscopy and HPLC for standardization.[20]

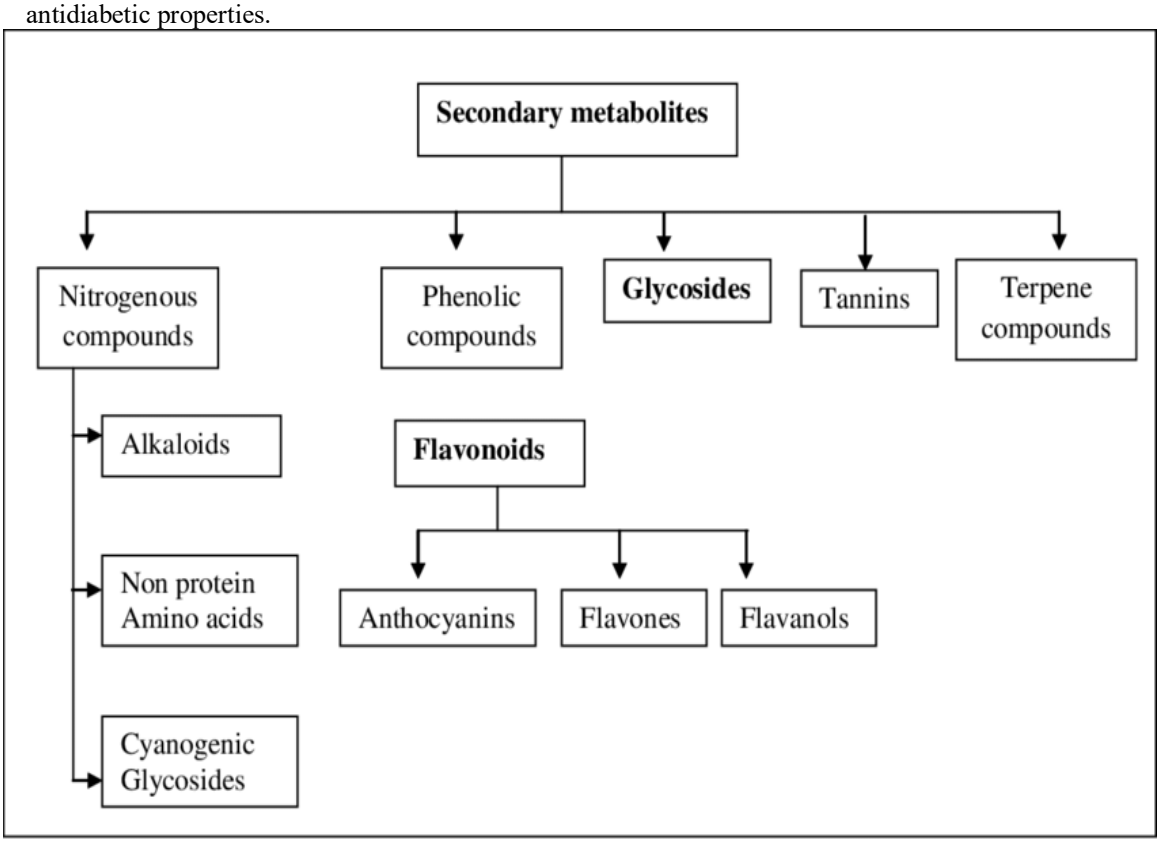

Fig. 5.2: Classification and Biosynthetic Origin of Secondary Metabolites in *Tecoma stans*

The presence of these diverse phytochemicals explains the strong pharmacological profile of *Tecoma stans*. Their combined action supports antioxidant defense, infection control, and tissue regeneration, making the plant suitable for topical gel formulation in wound management. In the next section, the detailed pharmacological activities of *Tecoma stans* will be discussed.[21]

6. PHARMACOLOGICAL ACTIVITIES OF *Tecoma stans*

The medicinal importance of **Tecoma stans** is supported by various pharmacological studies. The plant exhibits multiple biological activities that are directly related to wound healing, especially in diabetic conditions. These activities are mainly due to its rich content of flavonoids, alkaloids, phenolic compounds, and naphthoquinones.[22]

6.1 Antioxidant Activity

Oxidative stress plays a major role in delayed wound healing. Excess production of reactive oxygen species (ROS) damages cells and prolongs inflammation. Extracts of *Tecoma stans* have shown strong antioxidant activity in laboratory studies such as DPPH and FRAP assays. Flavonoids like quercetin and phenolic compounds such as chlorogenic acid help neutralize free radicals. By reducing oxidative stress, the plant extract protects tissues and supports faster regeneration.[23]

6.2 Anti-inflammatory Activity

Inflammation is necessary during the early stage of wound healing, but excessive inflammation can delay recovery. Studies show that *Tecoma stans* extract reduces inflammatory mediators like TNF-α and interleukins. It also inhibits certain enzymes involved in inflammation. This helps decrease swelling, redness, and pain, allowing the wound to progress to the next healing stage smoothly.[24]

6.3 Antimicrobial Activity

Infection is one of the most common causes of delayed wound healing. *Tecoma stans* has demonstrated antibacterial activity against common wound pathogens such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli*. Alkaloids like tecomine and compounds like lapachol contribute to this antimicrobial effect. By preventing bacterial growth, the plant extract reduces the risk of chronic wounds.[25]

6.4 Antidiabetic Activity

Since diabetic wounds are difficult to treat, the antidiabetic property of *Tecoma stans* adds additional therapeutic value. Studies have reported that the plant extract helps reduce blood glucose levels and improve insulin function. This is important because better glucose control improves blood circulation and enhances wound healing in diabetic patients.[26]

6.5 Wound-Healing Activity

Animal studies using excision and incision wound models have shown that *Tecoma stans* extract accelerates wound contraction and epithelialization. It increases collagen deposition and improves tensile strength of healed tissue. The combined antioxidant, anti-inflammatory, antimicrobial, and hypoglycemic actions contribute to its overall wound-healing potential.[27]

7. Topical Gel Formulation of *Tecoma stans*

The conversion of **Tecoma stans** extract into a topical gel system improves its therapeutic application in wound management. Although the crude extract possesses strong antioxidant, antimicrobial, anti-inflammatory, and antidiabetic properties, its direct use may result in instability, uneven dosing, and poor patient acceptance. A gel formulation provides a more stable, uniform, and patient-friendly dosage form suitable for long-term wound care.[28]

7.1 Advantages of Gel Dosage Form

Topical gels are semi-solid preparations with high water content. They are non-greasy, easily spreadable, and comfortable to apply. Unlike ointments, gels do not leave an oily residue, which improves patient compliance. Their cooling effect provides soothing relief, particularly in inflamed or infected wounds. Additionally, gels maintain a moist environment at the wound site, which is essential for proper healing. Moisture promotes cell migration, collagen formation, and faster re-epithelialization.[29]

7.2 Role of Polymeric Base

In herbal gel systems, the extract is uniformly dispersed within a polymeric matrix. Polymers such as Carbopol and Hydroxypropyl Methylcellulose (HPMC) are commonly discussed in pharmaceutical literature for gel preparation. These polymers provide appropriate viscosity, stability, and consistency. The polymer network helps control the release of active phytoconstituents and ensures prolonged contact with the wound surface. This sustained release enhances local therapeutic action without significant systemic absorption.[30]

7.3 Significance of Ethanolic Extract

Ethanol is an effective solvent for extracting flavonoids, alkaloids, and phenolic compounds from *Tecoma stans*. These compounds are mainly responsible for the plant's pharmacological activities. Incorporating the ethanolic extract into a gel improves its solubility and uniform distribution. Gradual release of bioactive compounds from the gel matrix ensures continuous antioxidant and antimicrobial effects at the wound site.[31]

Overall, topical gel formulation enhances stability, bioavailability, and patient acceptability of *Tecoma stans* extract, making it a promising system for chronic and diabetic wound management.

8. Analytical Standardization of *Tecoma stans* Extract

Herbal formulations require proper standardization to ensure safety, quality, and reproducibility. Unlike synthetic drugs, plant extracts contain multiple active compounds, and their concentration may vary due to environmental and processing factors. Therefore, analytical standardization is essential to maintain consistency in therapeutic effectiveness.[32]

8.1 Importance of Standardization

Standardization ensures that each batch of extract contains a defined amount of bioactive compounds. It helps confirm the identity, purity, and strength of the formulation. Without proper analytical evaluation, variability in phytochemical composition may lead to inconsistent pharmacological results. For a medicinal plant like *Tecoma stans*, identifying marker compounds is crucial for quality control.[33]

8.2 UV–Visible Spectroscopy

UV–Visible spectroscopy is commonly used for preliminary analysis of plant extracts. Many phytochemicals, especially flavonoids and phenolic compounds, absorb light in the ultraviolet region. By measuring absorbance at specific wavelengths, it is possible to estimate total phenolic and flavonoid content. This technique is simple, rapid, and cost-effective, making it useful for routine quality assessment.

8.3 High-Performance Liquid Chromatography (HPLC)

High-Performance Liquid Chromatography (HPLC) is a more advanced and precise analytical method. It separates individual components of the extract and allows accurate quantification of marker compounds such as quercetin, chlorogenic acid, and lapachol. HPLC provides a characteristic chromatographic fingerprint, which ensures batch-to-batch consistency and regulatory compliance.[34]

8.4 Role of Marker Compounds

Marker compounds serve as reference standards for quality control. In *Tecoma stans*, flavonoids and phenolic acids are commonly used as markers due to their therapeutic relevance. Quantifying these compounds ensures that the formulation maintains consistent antioxidant and wound-healing potential.

In summary, analytical standardization using UV–Visible spectroscopy and HPLC strengthens the scientific credibility of *Tecoma stans* gel formulations and supports their safe and effective use in wound management.

9. Method Validation According to ICH Guidelines

For herbal formulations like **Tecoma stans** gel, analytical methods must be validated to ensure accuracy, precision, and reliability. Method validation confirms that the analytical procedure used for quantifying marker compounds is suitable for its intended purpose. International guidelines such as ICH (International Council for Harmonisation) provide standard parameters for validation.[35]

9.1 Specificity

Specificity refers to the ability of the analytical method to measure the desired compound without interference from other components such as excipients, impurities, or degradation products. In HPLC analysis of *Tecoma stans*, clear separation of marker compounds like quercetin and chlorogenic acid indicates good specificity.

9.2 Linearity and Range

Linearity determines whether the analytical response is directly proportional to the concentration of the analyte within a specific range. A high correlation coefficient (r^2 close to 1) indicates acceptable linearity.

9.3 Accuracy and Precision

Accuracy represents the closeness of measured values to the true value, while precision indicates repeatability of results under the same conditions. These parameters ensure reproducible quantification of phytochemicals in the extract.[36]

9.4 Limit of Detection (LOD) and Limit of Quantification (LOQ)

LOD and LOQ determine the smallest detectable and quantifiable amounts of the marker compound. These parameters ensure sensitivity of the analytical method.

Proper validation ensures quality control, batch consistency, and regulatory acceptance of *Tecoma stans* gel formulations.[37]

10. CONCLUSION AND FUTURE SCOPE:

The present review highlights the therapeutic potential of *Tecoma stans* in wound management, particularly under diabetic conditions. The plant contains important phytochemicals such as flavonoids, alkaloids, phenolic compounds, and naphthoquinones, which contribute to antioxidant, anti-inflammatory, antimicrobial, and antidiabetic activities. These combined actions make it a promising natural candidate for developing topical wound-healing formulations.

Incorporating the ethanolic extract into a gel system enhances stability, local drug delivery, and patient compliance. Analytical standardization using UV–Visible spectroscopy and HPLC ensures consistency, quality, and reproducibility of the formulation. Method validation according to ICH guidelines further strengthens its scientific and regulatory acceptance.

Future research should focus on advanced drug delivery systems such as nano-gels, phytosomal formulations, and controlled-release systems to improve dermal penetration and therapeutic efficiency. Clinical studies in human subjects are

also necessary to confirm safety and efficacy. Additionally, establishing multi-marker standardization and Good Manufacturing Practice (GMP) guidelines will support large-scale production.

Overall, *Tecoma stans* represents a promising herbal candidate for safe, effective, and standardized wound-healing therapy in modern pharmaceutical practice.

REFERENCES:

1. Guo S, DiPietro LA. Factors affecting wound healing. *Journal of Dental Research*. 2010;89(3):219–229.
2. Patel DK, Kumar R, Laloo D, Hemalatha S. Natural medicines from plant sources used for diabetic wound healing. *Journal of Ethnopharmacology*. 2012;144(2):266–277.
3. International Council for Harmonisation (ICH). ICH Harmonised Tripartite Guideline Q2(R1): Validation of Analytical Procedures—Text and Methodology. Geneva: ICH; 2005.
4. Rodrigues M, Kosaric N, Bonham CA, Gurtner GC. Wound healing: A cellular perspective. *Physiological Reviews*. 2019;99(1):665–706.
5. Clark RAF. Biology of dermal wound repair. *Dermatologic Clinics*. 1993;11(4):647–666.
6. Eming SA, Krieg T, Davidson JM. Inflammation in wound repair: Molecular and cellular mechanisms. *Journal of Investigative Dermatology*. 2007;127(3):514–525.
7. Singer AJ, Clark RAF. Cutaneous wound healing. *New England Journal of Medicine*. 1999;341(10):738–746.
8. Baum CL, Arpey CJ. Normal cutaneous wound healing: Clinical correlation with cellular and molecular events. *Dermatologic Surgery*. 2005;31(6):674–686.
9. Falanga V. Wound healing and its impairment in diabetes mellitus. *The Lancet*. 2005;366(9498):1736–1743.
10. Bitar MS. Diabetes and impaired wound healing: Pathophysiology and therapeutic perspectives. *International Journal of Biochemistry and Cell Biology*. 2012;44(3):476–483.
11. Brem H, Tomic-Canic M. Cellular and molecular basis of wound healing in diabetes. *Journal of Clinical Investigation*. 2007;117(5):1219–1222.
12. Kumar S, Pandey AK. Chemistry and biological activities of flavonoids: An overview. *Scientific World Journal*. 2013;2013:162750.
13. Boots AW, Haenen GRMM, Bast A. Health effects of quercetin: From antioxidant to nutraceutical. *European Journal of Pharmacology*. 2008;585(2–3):325–337.
14. Middleton E, Kandaswami C, Theoharides TC. The effects of plant flavonoids on inflammatory cells. *Pharmacological Reviews*. 2000;52(4):673–751.
15. Cowan MM. Plant products as antimicrobial agents. *Clinical Microbiology Reviews*. 1999;12(4):564–582.
16. Kumar B, Vijayakumar M, Govindarajan R, Pushpangadan P. Ethnopharmacological approaches to wound healing—Exploring medicinal plants of India. *Journal of Ethnopharmacology*. 2007;114(2):103–113.
17. Nayak BS, Sandiford S, Maxwell A. Evaluation of wound-healing activity of ethanolic extract of medicinal plants. *Evidence-Based Complementary and Alternative Medicine*. 2009;6(3):351–356.
18. Harborne JB. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 3rd ed. London: Chapman and Hall; 1998.
19. Trease GE, Evans WC. Pharmacognosy. 16th ed. London: Saunders Elsevier; 2009.
20. Snyder LR, Kirkland JJ, Dolan JW. Introduction to Modern Liquid Chromatography. 3rd ed. Hoboken: John Wiley & Sons; 2010.
21. Skoog DA, Holler FJ, Crouch SR. Principles of Instrumental Analysis. 6th ed. Belmont: Thomson Brooks/Cole; 2007.
22. Gupta VK, Jain R, Mishra A, et al. Antioxidant and anti-inflammatory potential of medicinal plants. *Pharmacognosy Reviews*. 2010;4(8):117–126.
23. Brand-Williams W, Cuvelier ME, Berset C. Use of free radical method to evaluate antioxidant activity. *LWT – Food Science and Technology*. 1995;28(1):25–30.
24. Aggarwal BB, Harikumar KB. Potential therapeutic effects of curcumin and natural phytochemicals. *International Journal of Biochemistry and Cell Biology*. 2009;41(1):40–59.
25. Nostro A, Germano MP, D'Angelo V, Marino A, Cannatelli MA. Extraction methods and antimicrobial activity of medicinal plants. *Letters in Applied Microbiology*. 2000;30(5):379–384.
26. Modak M, Dixit P, Londhe J, Ghaskadbi S, Devasagayam TPA. Indian herbs and antidiabetic potential. *Journal of Clinical Biochemistry and Nutrition*. 2007;40(3):163–173.
27. Murthy S, Gautam MK, Goel S, et al. Evaluation of wound healing activity of plant extracts. *International Journal of Low Extremity Wounds*. 2013;12(2):91–99.
28. Aulton ME, Taylor KMG. Aulton's Pharmaceutics: The Design and Manufacture of Medicines. 5th ed. London: Churchill Livingstone; 2018.
29. Allen LV. Pharmaceutical Dosage Forms and Drug Delivery Systems. 10th ed. Philadelphia: Lippincott Williams & Wilkins; 2014.

30. Rowe RC, Sheskey PJ, Quinn ME. Handbook of Pharmaceutical Excipients. 6th ed. London: Pharmaceutical Press; 2009.
31. Kalia YN, Guy RH. Modeling transdermal drug release. *Advanced Drug Delivery Reviews*. 2001;48(2–3):159–172.
32. World Health Organization. Quality Control Methods for Herbal Materials. Geneva: WHO Press; 2011.
33. Kunle OF, Egharevba HO, Ahmadu PO. Standardization of herbal medicines—A review. *International Journal of Biodiversity and Conservation*. 2012;4(3):101–112.
34. Dong MW. Modern HPLC for Practicing Scientists. Hoboken: John Wiley & Sons; 2006.
35. International Council for Harmonisation (ICH). ICH Guideline Q2(R2): Validation of Analytical Procedures. Geneva: ICH; 2022.
36. Shrivastava A, Gupta VB. Methods for determination of LOD and LOQ. *Chronicles of Young Scientists*. 2011;2(1):21–25.
37. Blessy M, Patel RD, Prajapati PN, Agrawal YK. Development of stability-indicating methods. *Journal of Pharmaceutical Analysis*. 2014;4(3):159–165.