

Formulation and characterization of herbal wound Healing gel

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ABSTRACT

As medicine according to ancient medicinal systems. In this research paper, plant leaf samples undergo phytochemical investigation through gas chromatography-mass spectrometry (GC-MS). As the result of GC-MS spectra we identified twenty-three phytochemical compounds in methanolic extract of *C. roseus* leaves. The identification of phytochemical compounds is based on the peak area, retention time, molecular weight and molecular formula. Compounds present to a major extent are specified with their NMR, IR, and Mass spectrometry *Catharanthus roseus* (periwinkle) is a medicinal plant that belongs to the Apocynaceae family. All parts of this plant are used data. This spectral analysis helps in the discovery of novel phytochemicals in the plant extract of this plant. We can guess about any novel phytochemicals that can be further used as synthetic units in organic synthesis reactions because natural synthetic units used in any process will always be environmentally friendly and follow green chemistry principles. Ayurveda is an Indian method of adjusting treatment according to the clinical potential of the plant. *C. roseus* (Madagascar periwinkle) is a wonderful herb from Ayurveda. It is known for its antitumor, diabetic, antibacterial, oxidative antagonism and mutagenic effects. The island of Madagascar is the greenery that inhabits the island. The colors range from pink to purple, and the leaves are inverted. It produces about 130 alkaloids. Most of them are aymalicin, vinsane, reserine, vincristine, vinblastine, and laubacin. Vincristine and vinblastine are used to treat a variety of dangerous conditions, including Hodgkin's disease, breast disease, dangerous skin growth, and lymphocytic leukemia. It is an endangered species that should be monitored using techniques such as micro transplantation. All in all, there are many useful properties to be investigated.

Keywords: *Catharanthus roseus*, alkaloids, vinblastine, vincristine, anti- cancer.

INTRODUCTION

Wound healing or wound repair is the body's natural process of regenerating dermal and epidermal tissue. Healing requires the mutual efforts of various tissues and cell lineages. The present work is an attempt to develop cream containing aqueous extract of CA using principles of formulation design and design of experiment strategy to desired spreading and drug release properties. The allopathic system offers two conventional treatments for rheumatoid arthritis, but they come with side effects. Therefore, ayurvedic herbal drug formulations are a safer, effective, and time-tested alternative. Moreover, Indian folk medicine comprises numerous prescriptions for therapeutic purposes such as healing of wounds, inflammation, skin infections, leprosy, diarrhea, scabies, venereal disease, ulcers, snake bite, etc. ^[1]

Skin diseases that are usually complicated by secondary bacterial invasion can be broadly classified into itchy skin conditions in which scratching provides a portal of entry to microorganisms such as scabies and pediculosis, and those characterized by absence of skin barrier, such as eczema, pemphigus and ulcers. Several bacteria species typically directly invade intact skin due to its anatomical and physiological features. Staphylococcal scalded skin syndrome (SSSS) is a potentially fatal toxin-mediated disease primarily affecting infants, but can also affect children and adults. Polymers are repeating units used to form a structural network essential for gel preparation, and they are classified into various types, including gel-forming bases ^[2].

Wound healing involves four phases: haemostasis, inflammation, proliferation, and remodeling, which are distinct yet overlapping. Wounds are treated to

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

expedite healing and reduce complications. Herbal medicines are widely utilized as alternative wound treatments.^[3] Topical gel preparations are semi-solid formulations used for skin application or local action or percutaneous penetration of a medication, typically consisting of a liquid phase thickened with other components. The juice is collected and applied externally to affected areas, providing anti-inflammatory action.^[4] This traditional medicine is used for various purposes, including laxative, astringent, expectorant, purgative, binding, cooling, and aphrodisiac, and is known to cure various skin disorders and blood diseases.^[5]

Wound healing is a complex process involving hemostasis, inflammation, proliferation, and remodeling stages. The goal of wound management is to heal the wound quickly and minimize pain, discomfort, and scarring for the patient. NEs are isotropic mixture of oil, surfactant/cosurfactant (Smix), and water with droplet diameter approximately in the range of 10–200 nm. The present work involves the development of NE gel of SBT seed oil for topical application and evaluates its wound healing potential.^[6]

Wounds disrupt the anatomic or functional continuity of living tissue, and in the normal setting, healing

occurs through an orderly, timely reparative process, resulting in sustained restoration of anatomic and functional integrity. *Eupatorium glandulosum* Michx is a large, branching undershrub with simple, opposite, subsessile, lanceolate, subentire, and glabrous leaves used in Indian folklore medicine for its astringent, thermogenic, and stimulant properties.^[7]

The research focuses on the development of a polyherbal gel with improved wound healing activity, shelf life, and stability, which is preferred for topical formulation due to its convenience and effectiveness in wound area application. The study evaluated the pharmaceutical parameters and stability of gel formulations, which were then applied for wound healing studies.^[8]

Wounds disrupt tissue's anatomic continuity due to harmful exposure to physical, chemical, thermal, microbial, or immunological stimuli. The wound-healing process consists of four integrated phases, involving physical, chemical, thermal, microbial, or immunological stimuli.

Most single synthetic drug formulations in the market are not reliable in their wound healing properties.^[9]

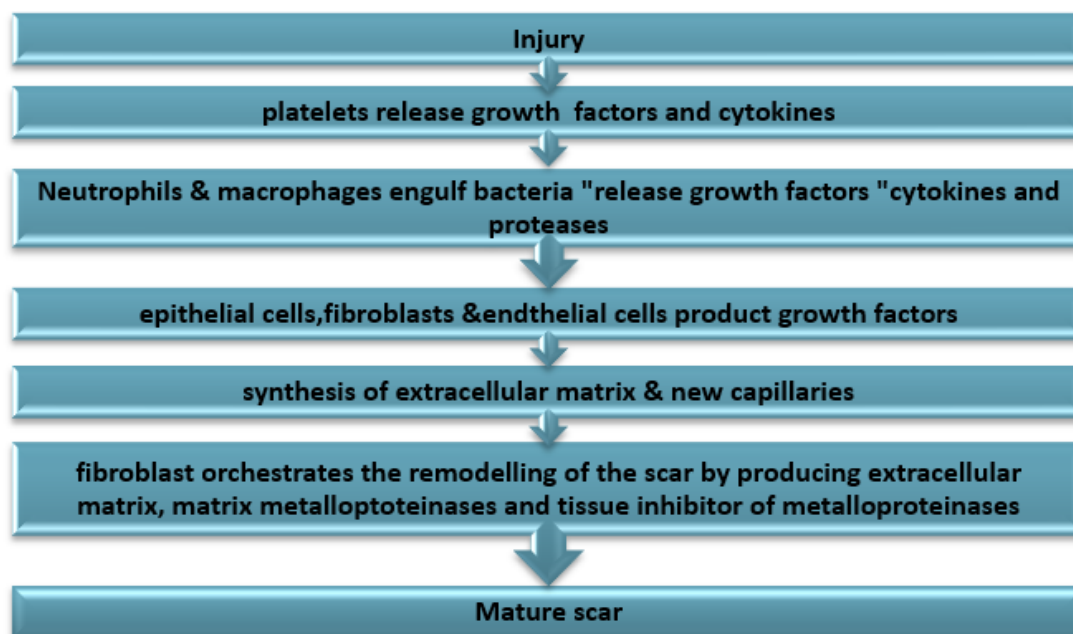


Fig. no 1 : MOA of wound healing

No1: Leaves of Catharanthus Roseus

1 Physical description-

- Leaves: Opposite, elliptic to obovate, dark green
- Flowers: Five-petaled, blue, pink, purple, or white, star-shaped
- Stem: Herbaceous, upright or trailing
- Height: 6-18 inches (15-45 cm)
- Spread: 6-12 inches (15-30 cm)
- Root system: Fibrous roots or shallow roots
- Texture: Medium to fine texture
- Foliage: Evergreen or semi-evergreen
- Growth habit: Upright or trailing, spreading
- Flowers: Small, star-shaped, borne in clusters or terminal racemes

Bloom time: Continuously throughout the growing season^[10]

2 Biological sources:-

It also known as catharanthus and Madagascar periwinkle. It belongs to Apocynaceae family. The biological source of vinca is the dried entire plant and aerial part of Catharanthus roseus Linn.

3 Family:

Catharanthus is a genus of flowering plants in the family Apocynaceae.

4 Uses:

Periwinkles have a variety of uses, including:

- Ornamental: Periwinkles are often grown for their attractive blue, pink, purple, or white flowers, which bloom continuously throughout
- the growing season. They are often used as ground covers, edging plants, or in container gardens.

- Medicinal: The Madagascar periwinkle (Catharanthus roseus) is used in traditional medicine as a remedy for a variety of ailments, including diabetes, cancer, and heart disease.

- Soil erosion control: Periwinkles are used in landscaping and gardening to control soil erosion due to their ability to spread and form a dense mat of foliage.

- Invasive species control: In some areas, periwinkles can become invasive and cause problems by outcompeting native plant species. In these situations, periwinkles can be used for controlling erosion on slopes and in other areas where vegetation is difficult to establish.

- Cut flowers: Periwinkles can also be used as cut flowers for floral arrangements. [11]

• 5 Traditional use:

He species has long been cultivated for herbal medicine, as it can be traced back to 2600 BC Mesopotamia. In Ayurveda (Indian traditional medicine) the extracts of its roots and shoots, although poisonous, are used against several diseases. [12]

Pharmacological activity: [13]

- Anticancer activity
- Antimicrobial activity
- Anti-oxidant property
- Anti-Diarrheal property
- Wound healing property.

Wound Healing: [14]

Wound healing is a natural physiological reaction to tissue injury. However, wound healing is not a simple phenomenon but involves a complex interplay between numerous cell types, cytokines, mediators, and the vascular system. The cascade of initial vasoconstriction of blood vessels and platelet aggregation is designed to stop bleeding. This is followed by an influx of a variety of inflammatory cells, starting with the neutrophil. These



inflammatory cells, in turn, release a variety of mediators and cytokines to angiogenesis, promote thrombosis, epithelialization. and re-The fibroblasts, in turn, lay down extracellular components which will serve as scaffolding.

The inflammatory phase is characterized by hemostasischemotaxis, and increased vascular permeability, limiting further damage, closing the wound, removing cellular debris and bacteria, and fostering cellular migration. The duration of the inflammatory stage usually lasts several days.

The proliferative phase is characterized by the formation of granulation re-epithelialization, tissue, and neovascularization. This phase can last several weeks. The maturation and remodeling phase is where the wound achieves maximum strength as it matures.

Types of wound healing: [15]

□ Primary wound healing: Primary wound healing, or primary intention wound healing, refers to when doctors close a wound using staples, stitches, glues, or other forms of wound-closing processes

□ Secondary wound healing: Secondary wound healing, or secondary intention wound healing, occurs when a wound that cannot be stitched causes a large amount of tissue loss. Doctors will leave the wound to heal naturally in these cases.

□ Tertiary wound healing: Tertiary wound healing, or healing by delayed primary closure, occurs when there is a need to delay the wound-closing process. This could be necessary if a doctor fears that they may trap infectious germs in a wound by closing it. In these cases, they may allow the wound to drain or wait for the effects of other therapies to take place before closing the wound. Wounds:

□ Wounds:

□ A wound is any type of damage or breakage on the surface of the skin.

□ The wounds can be due to accidents like burns, paper cuts, skin tears or surgical, any underlying disease, or some other skin conditions that

may develop in the wound, for example, eczema or psoriasis[16]

Types Of Wounds [17]

Wounds can be classified in several ways depending on the healing time and the necessity to consult with Wound Care Specialists depending on the severity of a particular wound. People are likely to suffer from different types of wounds throughout life while performing daily activities. Depenion

the cause, site, and depth, a wound can lead from simple to severe one. Here, we have explained different types of wounds. Let's have a look:

Open or Closed Wounds can be open or closed. Open wounds are the wounds with exposed underlying tissue/ organs and open to the outside environment, for example, penetrating wounds. On the other hand, closed wounds are the wounds that occur without any exposure to the underlying tissue and organs.

Acute or Chronic - A wound can be classified as acute or chronic depending on the healing time. Acute wounds are those that heal without any complications in a predicted amount of time. While chronic wounds, on the other hand, are those that take a relatively long time to heal with some complication

Treatment:-[18]

1.Cleaning to remove dirt and debris from a fresh wound . this is the done very gently and often in the shower.

2.Vaccinating for tetanus may be recommended in some cases of traumatic injury.

3.Exploring a deep wound surgically may be necessary. Local anesthetic will be given before the examination.

4.Removing dead skin surgically. local anesthetic will be given

5.Closing large wounds with stitches or staples.

6.Dressing the wound

3.2 Preclinical and Clinical Studies



Rationale/ Significance:

The periwinkle plant (scientific name: Vinca or Catharanthus), also known as the common periwinkle, is a beautiful and delicate plant native to Europe, Africa, and Asia. This hardy plant is known for its bright blue or violet flowers, which bloom from spring to fall [1]. It also known as catharanthus The periwinkle plant (scientific name: Vinca or Catharanthus), also known as the common periwinkle, is a beautiful and delicate plant native to Europe, Africa, and Asia. This hardy plant is known for its bright blue or violet flowers, which bloom from spring to fall [1]. It also known as catharanthus and Madagascar periwinkle. It belongs to Apocynaceae family. The biological source of vinca is the dried entire plant and aerial part of Catharanthus roseus Linn. Wound healing is a natural physiological reaction to tissue injury. However, wound healing is not a simple phenomenon but involves a complex interplay between numerous cell types, cytokines, mediators, and the vascular system. The cascade of initial vasoconstriction of blood vessels and platelet aggregation is designed to stop bleeding. This is followed by an influx of a variety of inflammatory cells, starting with the neutrophil. The proliferative phase is characterized by the formation of granulation tissue, re-epithelialization, and neovascularization.

This phase can last several weeks. The maturation and remodeling phase is where the wound achieves maximum strength as it matures. Periwinkles are often grown for their attractive blue, pink, purple, or white flowers, which bloom continuously throughout the growing season. They are often used as ground covers, edging plants, or in container gardens. The Madagascar periwinkle (Catharanthus roseus) is used in traditional medicine as a remedy for a variety of ailments, including diabetes, cancer, and heart disease. Periwinkles are used in landscaping and gardening to control soil erosion due to their ability to spread and form a dense mat of foliage. In some areas, periwinkles can become invasive and cause problems by outcompeting native plant species. In these situations, periwinkles can be used for controlling erosion on slopes and in other areas where vegetation is difficult to establish. Periwinkles can also be used as cut flowers for floral arrangements

1. Soil erosion control: Periwinkles are used in landscaping and gardening to control soil erosion due to their ability to spread and form a dense mat of foliage

2. Invasive species control: In some areas, periwinkles can become

3. Cut flowers: Periwinkles can also be used as cut flowers for floral arrangements.

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MATERIALS AND METHODS:**1: List of materials**

Sr.No.	Particular	Quantity
1.	Cathrathus roseus extract	1gm
2.	Carbapol 934	1gm
3.	Methyl paraben	0.2gm
4.	Propylene glycol	5ml
5.	Propyl paraben	0.1g
6.	Triethanolamine	1.2ml
7.	Distilled water	Qs

Glassware's and instruments:

1. Beaker
2. Measuring cylinder
3. Glass rod
4. Mixer
5. Burner
6. Conical flask
7. weighing balance
8. Ph meter
9. Heating mental

Formulation procedure:

- i. Kept Accurately weighed Carbopol 934 was taken in a beaker and dispersed in 50 ml of distilled water.
- ii. the beaker aside to swell the Carbopol for half an hour and then stirring should be done using mechanical/lab stirrer at 1200 rpm for 30 min.
- iii. Take 5 ml of propylene glycol and required quantity of Extract.
- iv. Take 5 ml Finally, volume made up to 100 ml by adding remaining distilled water and Triethanolamine was added drop wise to the formulations for adjustment of required skin pH (6.8-7) and to obtain the gel at required consistency.
- v. propylene glycol in another beaker and add weighed quantity of propyl paraben and methyl paraben to it and stirred properly.

vi. After all, Carbopol dispersed, 1 gm extract and preservatives solutions were added with constant stirring.

Tests for Herbal Gel

A. Physical evolution of gel: -

1. Color: The color of the formulation was checked out against white Background.

2. Oduor: Theodourof the gel was checked by mixing the gel in Water and taking the smell.

3. Consistency: The consistency was checked by applying on skin.

4. Greasiness: The greasiness was assessed by the application on to the s Color: The color of the formulation was checked out against white Background.

5. Grittiness: The formulation was evaluated microscopically under 40x magnifications for the presence of any particulate matter OR aggregates.

6. Homogeneity: Homogeneity was tested by visual inspection after allowing them to set in a container. They were evaluated for their appearance And presence of aggregates.

B. pH Determination:

About 20mg of the formulation was taken in a beaker and was subjected to the pH measurement using a digital pH meter Within 24hrs. of manufacture.

C. Spreadability:

The spreadability of the Periwinkle was measured by spreading of 0.5 g of the gel on a circle of 2 cm diameter pre-marked on a glass plate and then a second glass plate was employed. Half kilogram of weight was permitted to rest on the upper glass plate for 5 min. The diameter of the circle after spreading of the gel was determined.

Formula: - $S = M \cdot L / T$ Here,

M = weight tied to upper slide L = length of glass slides



T = time taken to separate the slides

D. Viscosity test:

The viscosity of the prepared gel was measured by using Brookfield Viscometer.

Prepared the gel with different concentration. Setup the base level of the instrument using level indicator. The spindle was cleaned and attached to the instrument. Then the spindle was rotated in the gel until a constant reading displaced on the viscometer. Repeat the method for three times and find out the average value.

E. Drug Content:

The drug content of the formulation will be determined by taking An accurately weigh quantity of gellgm in a 100 ml volumetric flask. 70 ml of methanol will be added to it and shake. The volume Will be made up to 100ml. A suitable filter paper will be used to Filter the contents effectively. 1ml filtrate will be taken and dilute And the drug content (extract) will be estimated using UV/Visible Spectrophotometer at 250 nm.

F. Stability study:

Stability study Physical stability test of the herbal gel was carried out for four weeks at various temperature conditions like 20C, 250C and 370C. The herbal gel was found to be physically stable at different temperature i.e. 20C, 250C, 370 C within four weeks.

G. Chemical Tests:

Acid value: -

0.5gm of gel was taken and dissolved in 10 times of absolute alcohol. It was heated on a hot plate for 5 min and 2 to 3 drops of phenolphthalein indicator was added to it and titrated with 0.1 N KOH until faint pink color appeared. Acid Value = $56.1 \times \text{Titre value} \times N \text{ of KOH} / \text{Weight of sample}$.

Peroxide value: -

In a separate 200 mL flask, 5 gm of gel sample of control (base) and formulations, 30 mL of acetic acid and chloroform solution were added and swirled

gently. Then 0.5 mL of potassium iodide solution was added with continuous shaking and 30 mL of water was added thereafter. Finally, the solution was then titrated with 0.1 M sodium thiosulfate solution with vigorous shaking. End point of titration was noted when yellow color almost disappears. Then 0.5 mL of 1% starch was added and titration was continued with vigorous shaking to release all iodine from chloroform layer, until blue color disappeared.

Peroxide value = $S \times M \times 1000 / \text{gm sample}$ Here,

S = mL of sodium thiosulfate

M = Molarity of sodium thiosulfate solution.

H. Antibacterial activity of polyherbal gel:

The antibacterial activity of formulated preparation was performed against Gram-positive (S. aureus NCIM 2654,) bacterial strain by agar well diffusion method with slight modifications. The suspension of respective test pathogens was prepared in sterile saline and used for further study. For the antimicrobial activity test pathogens were inoculated on the surface of sterile Muller and Hinton agar and spread on plates by using a sterile spreader. After that agar well was prepared aseptically with the help of a sterilized cork borer having a 0.7 cm diameter. Then 25 to 100 mg/ml weight of the test sample was added to the different wells of the respective test pathogen. Then plates were placed at 4 °C for 20 min for sample diffusion in a culture medium and transferred to an incubator at 37 °C for 24 hrs. Furthermore, the obtained results were compared with the well containing 1000 mg /ml Streptomycin as a positive control

RESULTS: -

Physical evaluation of gel:

On the basis of Organoleptic properties of herbal extract i.e Catharanthus roseus following observations are shown.

Table no.2: Observations of organoleptic Properties

Sr.no	Test	Observations
1	Colour	Dark Green
2	Odour	Characteristics
3	Greasiness	Non greasy
4	Consistency	Smooth
5	Homogeneity	Homogenous



pH Determination:

It was found to be in the range of 6.62 to 7.08, kept at different storage conditions for 5 days. pH of the formulations and base kept at 8°C for 5 days did not show much change and data were significant over control (base) during one month ($p < 0.03$). Interestingly at 40°C, formulation exhibited elevated change in pH (7.08), while the others remained slightly stable during 5 days study. Data of formulation at 40°C were found to be significant in following table.

Table no.3: pH of the formulation at different storage condition

Duration	Storage Condition	pH
1 days	8C ⁰	6.63
3 days	8C ⁰	6.87
5 days	8C ⁰	6.80

Table no.4: Spreadability

Test	Observation	Result
Spreadability	9.7gm.cm/sec	Easily Spreadable

Spreadability of the formulation were studied and found to be 9.7gm.cm/sec. the formulation was found to possess good spreadability.

Viscosity test:

Viscosity and Rheological properties of the formulation were found to be

5.51Cps. The data of viscosity in formulation were significant temperatures.

Drug content determination:

The observation of calibration curve and absorbance of herbal extract of lantana camera leaves.

Chemical tests:

Acid value peroxide value and total fatty matter for the formulations kept at different storage conditions were observed for 15days and the values for formulation were found within the range. Acid value

was found to be in the range of 2.30 to 2.91 peroxide value was found to be in the range of 1.64 to 1.88 and total fatty matters were found to be in the range of 15.01 to 15.5 peroxide value data in formulation control at 80c and 40c were found to be significant ($p < 0.05$).

Antibacterial activity of gel:

Zone of inhibition of control and herbal formulation and control against *S. aureus* with different dilutions shown in following table.

Table no.5: Zone of inhibition

Bacteria used	Concentration Of sample (mg/ml)	Zone of Inhibition (mm)
<i>S. aureus</i>	25	17.10
	50	18.05
	75	19.75
	100	

Discussion:

Catharanthus roseus has a wide range of applications in the traditional system of medicine and it is used especially in cancer and diabetes, hypertension, antilactagogue etc. *C. roseus* have to exhibit many pharmacological activities such as antibacterial, antidiabetic, antimicrobial. The comparative toxicity of extracts and investigated in dose dependent manner. The investigation of toxicity showed that the extracts and isolated compounds are safe. 130 or more than its alkaloids have been found in which vincristine and vinblastine are anticancerous compound used in treatment of cancer. These anticancer alkaloids are derived from stem and leaf of *Catharanthus roseus*. Vinblastine is used experimentally for treatment of neoplasms and is recommended for Hodgkins's disease, chorio carcinoma.

The methanolic extract of *Catharanthus roseus* which play important role healing process and provide the strength to collagen tissue. wound Healing was assessed by the rate of wound contraction, period of epithelization, tensile strength (skin breaking strength). *C. roseus* Increased wound contraction and augmented with antimicrobial activity support the use



of *C. roseus* in the topical management of wound healing.

CONCLUSION:

Topical formulation of gel is directly applied to the skin where it is needed. They reduce side effect compared to systemic medication. Topical The topical gel formulation prepared for wound healing containing *Catharanthus roseus* methanolic extract. So *Catharanthus roseus* which is show antibacterial effect against *S. Aureus*. These gel-based formulation provides your skin with intense care it needs. Cosmetic which are formulated from various herbs that are safe on longer period of time. physicochemical properties of *Catharanthus roseus* extract gel are excellent.

administration of gel shows benefit in quick release of medicine at the site of action as compared to ointment. they show more advantages as compared to other preparation such as creams and ointment.

Quality control test for this gel preparation is safe and effective for herbal cosmetic product is very important thing hence, for treatment of wound healing *Catharanthus roseus* is best choice which show good antibacterial activity.

REFERENCES

1. Abdullzاهر, E.M. et al. Wound healing, Physiopedia. Available at https://www.physio-pedia.com/Wound_Healing. Alba Bhutkar, M.A. and Bhise, S.B. (2011). Comparative Studies on Antioxidant Properties of *Catharanthus Rosea* and *Catharanthus*. International Journal of Pharmaceutical Techniques. 3(3): 1551-1556
2. B.S. Nayak a et al. (2007) Evaluation of wound-healing potential of *catharanthus roseus* leaf extract in rats, Fitoterapia. Available at: <https://www.sciencedirect.com/science/article/abs/pii/S0367326X07001803?via%3Dihub>
3. Different types of wounds - wound care surgeons <https://www.woundcaresurgeons.org/blogs/know-about-different-types-of-wounds>
4. Fischhof PK, Moslinger-Gehmayr R, Herrmann WM, Friedmann A, Russmann DL. Therapeutic efficacy of Vincamine in dementia. Neuropsychobiology. 1996;34:29–35. [PubMed] [Google Scholar]
5. Gonzalez, A. and Johnson, J. (2021) Types of wound healing: Primary, secondary, Tertiary, and stages, Medical News Today. Available at: <https://www.medicalnewstoday.com/articles/types-of-wound-healing#secondary>.
6. Healing#secondary. Different types of wounds - wound care surgeons <https://www.woundcaresurgeons.org/blogs/know-about-different-types-of-wounds>
7. Himes RH. Interactions of the *catharanthus* (Vinc) alkaloids with tubulin and microtubules. Pharmacol Ther 1991;51:257-67.
8. Joel S. The comparative clinical pharmacology of vincristine and vindesine: Does vindesine offer any advantage in clinical use? Cancer Treat Rev 1996;21:513-25
9. Jordan MA, Thrower D, Wilson L. Effects of vinblastine, podophyllotoxin and nocodazole on mitotic spindles. Implications for the role of microtubule dynamics in mitosis. J Cell Sci 1992;102:401-16.
10. Khanam, S. (2021) A systematic review on wound healing and its promising medicinal plants, IP International Journal of Comprehensive and Advanced Pharmacology. Available at: <https://www.ijcap.in/html-article/13056>.
11. Kumar V and Srivastav AK: Phytochemical screening and quantitative analysis of extract from *Aegelemarmelos*, *Catharanthus roseus*, *Garcinia pedunculata*, *Musa paradisiaca* and *Ocimum sanctum*. European Journal of Molecular & Clinical Medicine 2021; 8(3)
12. Kufe DW, Pollock RE, Weichselbaum RR, Bast RC, Gansler TS, Holland JF, et al. Holland-Frei cancer medicine. 6th ed. Hamilton (ON): BC Decker Inc.; 2003.
13. Prajakta Patil, J. and Jai S. Ghosh (2010). Antimicrobial Activity of *Catharanthus roseus* – A Detailed Study. British Journal of Pharmacology and Toxicology. 1(1): 40-44.
14. Rowinsky EK, Donehower RC. Paclitaxel (taxol) N Engl J Med 1995;332:1004-14.
15. Swati, A.; Simi, J.; Nikkita, C.; Saloni, B.; Ayesha, T.; Vedamurthy, A.B. (2011). Evaluation of In-vitro Anthelmintic Activity of *Catharanthus roseus* Extract. International



- Journal of Pharmaceutical Sciences and Drug Research, 3(3): 211-213.
16. Schutz FA, Bellmunt J, Rosenberg JE, Choueiri TK. Vinflunine: Drug safety evaluation of this novel synthetic vinca alkaloid. Expert Opin Drug Saf 2011;10:645-53.
17. Wallace, H.A., Basehore, B.M. and Zito, P.M. (2023) Wound healing phases, Stat Pearls. <https://www.ncbi.nlm.nih.gov/books/NBK470464>
18. Wounds - how to care for them (2006) Better Health Channel. <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/wounds-how-to-care-for-the>.
19. Yousef, H., Alhajj, M. and Sharma, S. (2022a) Anatomy, skin (integument epidermis, Stat Pearls [Internet]. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK470464>
20. <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/wounds-how-to-care-for-the>.

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