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Formulation, Development and Quality Evaluation of A Polyherbal Wound Healing Ointment

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Abstract: *Wound healing is a coordinated biological process involving haemostasis, inflammation, proliferation and tissue remodelling. Delayed healing may occur when these phases are disrupted by infection, poor circulation, diabetes, malnutrition, repeated trauma or other systemic and local factors. This review considers the rationale for developing a polyherbal wound-healing ointment containing Neem (Azadirachta indica), Giloy (Tinospora cordifolia), Ashwagandha (Withania somnifera), Peepal (Ficus religiosa), Aloe vera (Aloe vera) and Arjuna (Terminalia arjuna). Tinospora cordifolia has been studied as an adjunct in diabetic foot-ulcer care, but the findings should not be interpreted as proof that a topical ointment is effective. The review outlines plant selection, extract standardization, ointment-base considerations, physicochemical evaluation, stability testing, microbiological quality and the need for ethically approved biological studies. A reproducible formulation, authenticated raw materials, suitable controls and transparent reporting are essential before efficacy or safety claims can be made.*

Keywords: Wound healing; polyherbal formulation; Azadirachta indica; Tinospora cordifolia; Withania somnifera; Aloe vera; Terminalia arjuna.

I. INTRODUCTION

Plants and their extracts have immense potential for the management and treatment of wounds. The phyto-medicines for wound healing are not only cheap and affordable but are also purportedly safe as hyper sensitive reactions are rarely encountered with the use of these agents[1].

The skin forms a protective barrier against physical injury, microorganisms, chemical exposure and excessive water loss. A wound is a disruption of the normal structure and function of the skin or underlying tissue. Wounds may be acute, such as uncomplicated cuts and surgical incisions, or chronic, such as diabetic foot ulcers, venous ulcers and pressure injuries. Chronic wounds can remain in a prolonged inflammatory state and are influenced by infection, inadequate perfusion, repeated pressure, metabolic disease and other patient-related factors

Normal wound healing process is described in four phases : 1. Haemostasis, 2. Inflammation, 3. Proliferation and 4. Remodeling. Hemostasis prevents blood loss and forms blood clots. Inflammation supports removal of microbes and damaged tissues. Fibroblast, endothelial cells and keratinocyte contribute to granulation tissue formation, angiogenesis and re-epithelialisation done in proliferative phase and during remodeling, the extracellular matrix is reorganized and the wound gains strength over time.

II. MATERIALS AND METHODS

This review was prepared by systematically collecting, screening, and analyzing relevant literature on herbal wound healing ointment. Scientific articles, research papers and academic reports were identified through database such as Google Scholar , PubMed , Science Direct and authenticated herbal medicine journals. Publications discussing herbal

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constituents , extraction techniques, formulation approaches and evaluation parameters of polyherbal ointments were prioritized.

After collecting the sources, the content was organized based on key themes , including wound healing mechanism, traditional medicinal plants , formulation strategies and quality assessment parameters. Studies were compare to identify common findings , variations in methodology and reported therapeutic outcomes. Only credible, peer reviewed and experimentally valid data were included to maintain scientific accuracy. The final review integrates these insights to provide a comprehensive understanding of the development and evaluation of herbal wound healing ointment.

III. RESULTS

OVERVIEW OF WOUND HEALING

Wound healing is a complex biological process involving hemostasis, inflammation, proliferation, and tissue remodeling [2]

1. Haemostasis

Hemostasis is the first stage in wound healing that can last for two days. As soon as there is a wound on the body, the blood vessels in the wound area constrict to reduce the blood flow. At the same time, clotting factors are released at the wound site to coagulate with fibrin, resulting in a thrombus, which is more commonly known as a blood clot.

2. Inflammatory phase

Neutrophils and macrophages contribute to removal of microbes and cellular debris and release mediators that coordinate repair. Inflammation is necessary during early healing, but prolonged or poorly regulated inflammation can delay progression to the proliferative phase.

3. Proliferative phase

The proliferative phase starts on the third day after wounding and lasts for about 2weeks thereafter. It is characterized by fibroblast migration and deposition of newly-synthesized extracellular matrix, acting as a replacement for the provisional network composed of fibrin and fibronectin.

4. Remodelling phase

As the final phase of wound healing, the remodelling phase is responsible for the development of new epithelium and final scar tissue formation.

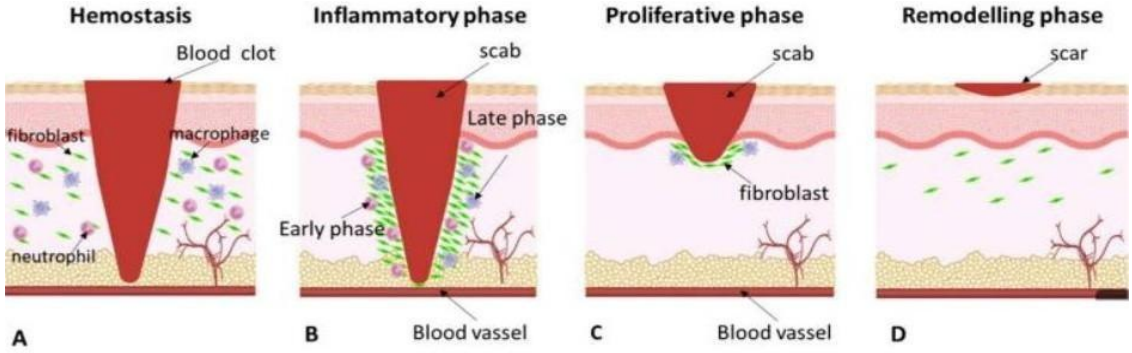


Fig. 1 Wound healing process

4.5 Factors affecting healing

Factors affecting wound healing include oxygenation, infection, age and sex hormones, stress , diabetes, obesity, medications, alcoholism, smoking and nutrition.

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IV. MEDICINAL PLANTS CONSIDERED

Sr. No.	Plants	Botanical name	Family
1	Arjuna	Terminalia Arjuna	Combretaceae
2	Neem	Azadiracta Indica	Meliaceae
3	Giloy	Tinospora Cordifolia	Menispermaceae
4	Ashwagandha	Withania Somnifera	Solanaceae
5	Peepal	Ficus Religiosa	Moraceae
6	Aloe Vera	Aloe Vera	Asphodelaceae

Table 1. Medicinal Plants

Arjuna (Terminalia arjuna)



Terminalia arjuna, commonly called Arjuna, is a tree in the family Combretaceae. Bark is a commonly investigated plant part and contains tannins and other constituents. Mukherjee and colleagues evaluated herbal formulations containing Arjuna bark extract in rat excision and incision wound models.

Rane and Mengi studied a 50% ethanolic bark extract and isolated tannins in incision and excision wound models[3]. The authors reported increased tensile strength and a greater reduction in wound size compared with control, with topical tannins performing better than the extract in the tested models.

Neem (Azadirachta indica.)



Neem is a tree belonging to the family Meliaceae and has a long history of use in traditional health practices. The choice of plant part is important because extraction yield, constituent profile and local tolerability can vary. The water extract group showed significant changes in wound contraction and tissue-related measurements compared with vehicle control, and histopathology supported the observations. A.Indica is also rich in various phytochemicals for

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pharmaceuticals such as alkaloids, steroids, flavonoids, terpenoids, fatty acids, and carbohydrates. The fungicidal potential of the tree is due to the presence of azadirachtin and nimbin[4].

Giloy (Tinospora cordifolia)



Tinospora cordifolia, commonly called Giloy or Guduchi, is a climbing plant in the family Menispermaceae. Published reviews describe diverse constituents, including alkaloids, terpenoids, lignans and other compound classes, and report a range of pharmacological activities.Purandare and Supe reported a prospective randomised controlled study of T. cordifolia adjunct in the surgical treatment of diabetic foot ulcers[5]

Ashwagandha (Withania somnifera)



Withania somnifera, commonly called Ashwagandha, belongs to the family Solanaceae. Its roots and other plant parts contain withanolides and other constituents, with composition depending on the material and extraction process. In wound-related research, a recent preclinical study examined Withania somnifera extract and extract-loaded nanoliposomes in mouse excisional wounds. The authors reported that ointments containing the nanoliposome preparations improved several healing-related measures, including collagen and epithelialisation, in that model[6].

Peepal (Ficus religiosa.)

Ficus religiosa, known as Peepal, belongs to the family Moraceae. Traditional uses of different plant parts are described in ethnomedicinal literature, but traditional use is not the same as controlled evidence for a defined topical product. The wound healing activity was investigate by excision and incision wound models using F. religiosa leaf extract. It has been reported that tannins possess ability to increase the collagen content, which is one of the factor for promotion of wound healing[7-8].

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Aloe vera (Aloe vera)

Aloe vera (AV) belongs to the Liliaceae family, of which the best-known species is Aloe Barbadensis Miller, and has been used for thousands of years in traditional medicine[9].



For topical formulation development, the raw material must be clearly defined as inner-leaf gel, a processed gel preparation or another specified material. Aloe gel is water-rich and may be difficult to incorporate into a traditional anhydrous ointment without a suitable formulation strategy. Polyherbal formulations are widely used in traditional systems of medicine like ayurveda for wound healing

VI. FORMULATION AND DEVELOPMENT CONSIDERATIONS

This section outlines a development framework, not a validated manufacturing formula.

1. Raw-material collection and authentication
2. Extraction
3. Extract quality and standardisation
4. General manufacturing sequence 5.Packaging and storage

VII. QUALITY EVALUATION OF THE OINTMENT

Quality evaluation should establish that the product is sufficiently uniform, physically acceptable, microbiologically suitable and stable for its intended research use.

7.1 Organoleptic and visual examination

Observe colour, odour, appearance, texture, homogeneity and visible particles.

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7.2 Homogeneity

Inspect the product for visible lumps, coarse particles, phase separation or inconsistent distribution.

7.3 pH

pH is relevant primarily to aqueous or water-dispersible systems. A conventional anhydrous ointment does not have a directly measurable pH unless a defined dispersion or extraction method is used.

7.4 Spreadability

Spreadability reflects how readily a semisolid spreads under an applied force. It may influence ease of application and patient acceptability.

7.5 Viscosity

Viscosity describes resistance to flow and can affect extrusion, spreading and product retention.

7.6 Extrudability

Extrudability is the ease with which the product can be expelled from its container.

7.7 Washability

This test is relevant to acceptability but should not be interpreted as a direct measure of wound-healing activity.

7.8 Stability testing

Monitor appearance, odour, homogeneity, phase separation, spreadability, viscosity, marker content where feasible and microbial quality at defined intervals. Storage conditions should be selected according to the product and relevant guidance.

7.9 Skin irritation and safety

The finished product should be assessed for irritation and sensitisation risk using ethically appropriate, validated methods.

VIII. DISCUSSION

The literature supports investigating medicinal plants as sources of candidate ingredients for topical wound-care products, but the strength of evidence differs substantially between plants and study designs. Neem stem-bark extract and Arjuna bark preparations have shown favourable findings in wound models. These results provide a scientific rationale for further study but do not prove effectiveness in humans. The clinical literature for Aloe vera is broader, particularly in burns, but systematic reviews differ in conclusions because of differences in products, wound types, comparators and study quality

The Tinospora cordifolia clinical study is relevant to the broader subject of wound management, but it evaluated the plant as an adjunct in diabetic foot-ulcer care rather than as a topical ointment [6] It should therefore be cited as context, not as direct validation of a topical formulation. The review should avoid language such as “proven wound healer”, “clinically effective” or “safe for all wounds” unless supported by direct evidence. A more appropriate conclusion is that the selected plants provide a rationale for formulation research and that the final combination requires systematic quality, safety and efficacy evaluation.

IX. CONCLUSION

Wound healing is a complex process influenced by local and systemic factors, and topical products must be evaluated in the context of appropriate wound care. The formulated polyherbal ointment exhibits beneficial properties and provides wound healing effects . Due to its simple preparation method and use of readily available ingredients, the ointment remains cost-effective. This polyherbal ointment is considered safe for external use. Evaluation through multiple tests suggests that the formulation is suitable for topical application to help prevent skin damage. The growing preference for natural remedies is largely due to their perceived safety and reduced risk of adverse effects compared to synthetic alternatives. Polyherbal formulations are effective in promoting the wound-healing process[11].

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