

Development of various Phytomedicine for Wound Healing Activity

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ABSTRACT:

Medicinal plants have been widely used for the treatment of wounds and various other diseases. Traditional knowledge combined with modern research has revealed that many plants possess significant wound healing potential. These effects are mediated through multiple mechanisms such as activation of NF- κ B, modulation of pro-inflammatory cytokines, induction of nitric oxide synthase, promotion of collagen (types I and III) synthesis, enhancement of antioxidant defenses, and stimulation of angiogenesis. Such properties contribute to faster tissue repair and restoration of skin integrity. The present review emphasizes the role of medicinal plants and their extracts in the treatment of cuts and wounds. Plant extracts are generally obtained from different parts of the plant or explants using solvents such as water, ethanol, and methanol, with extraction techniques including infusion, decoction, percolation, and maceration. Several in vitro and in vivo studies have demonstrated the wound healing activities of these extracts, thereby validating traditional claims. The process of wound healing is broadly classified into two aspects: the basic science aspect, which involves the four distinct phases of hemostasis, inflammation, proliferation, and remodeling; and the practical aspect, which is divided into acute and chronic wounds. Understanding both perspectives is crucial for the development of effective plant-based therapies. This review highlights medicinal plants with proven wound healing activity and supports their potential as safe, effective, and globally acceptable agents. It further strengthens the bridge between ethnomedicine and modern pharmacological validation for the management of wounds.

KEYWORDS: Herbal Phytomedicine, Wound Healing, formulation.

I. INTRODUCTION:

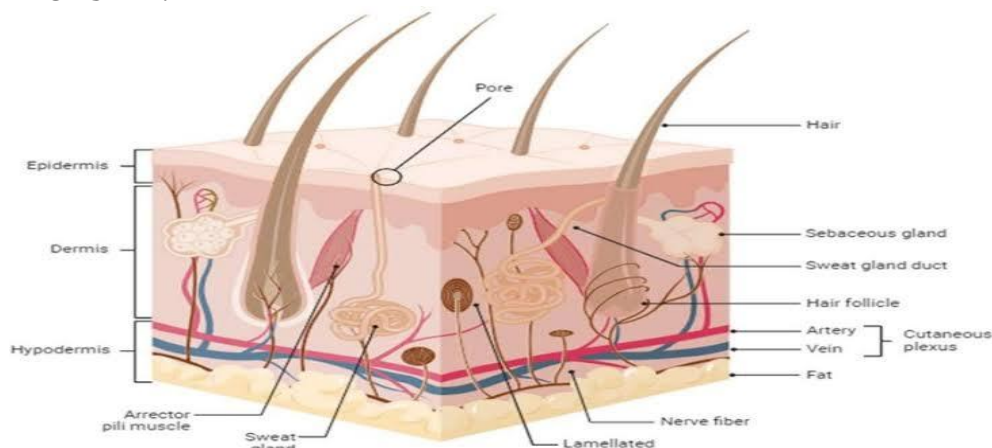
Herbal medicine refers to treatments made from parts of plants, such as bark, leaves, seeds, fruits, roots, stems, or flowers.¹ These plant-based remedies are thought to have health benefits. The World Health Organization (WHO) states that around 80% of people in developing countries rely on traditional medicines for their basic healthcare.² Medicinal plants and the active substances they contain have been used for a long time to help wounds heal faster. An approach that combines traditional knowledge with modern science helps us understand how these plants can be used for healing. For centuries, plants have been one of the first sources of treatment for humans and continue to be important in healthcare around the world. Herbal medicines, plant-based treatments, and products made from them are still widely used, especially in developing countries.³ Traditional knowledge about plant-based treatments has helped scientists discover new medicines and use natural resources in a sustainable way. In the past, plants were used as poultices to stop bleeding, speed up healing, or taken orally to improve health. This knowledge has been passed down through generations and has formed the basis of modern medicine. Even with modern medical advances, healing wounds remains a challenge.⁴ Each year, nearly 100 million people suffer from scars due to burns, accidents, or surgeries, leading to a high demand for effective treatments. The healing process is complex and involves several stages like immune responses, cell repair, and tissue growth, all of which medicinal plants can support through their active compounds.⁵

The skin, also known as the cutis or integument, is the largest organ of the body and serves as a vital protective barrier. It consists of three layers: the epidermis (outermost), the dermis (connective tissue layer), and the hypodermis

(subcutaneous adipose tissue). A wound is defined as a disruption in the integrity of skin or underlying tissues, commonly caused by accidents, surgery, or trauma. Wounds may be classified as incised wounds, lacerations, abrasions, punctures, or more specific types such as acute, chronic, closed, open,

penetrating, or gunshot wounds. Proper understanding aids effective wound management. As a result, exploring plant components from different plant families offers hope for finding affordable, effective, and sustainable treatments for wound healing.

ANATOMY OF SKIN :

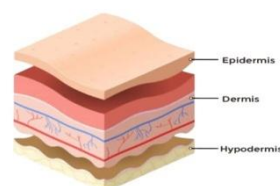


The skin is the largest organ of the human body, forming a protective covering over the entire surface. It acts as the first line of defense against environmental factors such as microbes, chemicals, heat, cold, and radiation. Beyond protection, the skin also regulates body temperature, prevents excessive water loss, enables sensation, and plays a role in immune defense and vitamin D synthesis. Structurally, the skin is composed of three main layers.

The epidermis, which provides protection and skin tone; the dermis, which contains connective tissue, blood vessels, glands, and hair follicles for strength and flexibility; and the hypodermis, a fatty layer that insulates and cushions. Together, these layers make the skin vital for survival and health, accounting for about 15% of the total adult body weight. It performs many vital functions, including protection against external physical, chemical biological assailants, as well as prevention excess water loss from the body and a role in thermoregulation.

There are three layers of skin :

LAYERS OF OUR SKIN



- ❖ Epidermis (Outer layer).
- ❖ Dermis (Middle layer).
- ❖ Hypodermis (Inner layer).

❖ Epidermis (outer layer) :

Epidermis is the outer layer of the skin, approximately 0.5 -1.5mm (depending on body part 0.5mm on the eyelids to 1.5mm on the palm of the hand and soles of feet) and avascular meaning does not have blood vessels .and is composed of keratinized .

Epidermis is composed of five epithelial layers are:

Stratum Corneum :

Uppermost and thickest section of epidermis consisting of 25-30 layers. the cell type in the area large and flat keratinocytes with no nucleus. The keratin and other structural proteins in these cells are tightly crossed and form

impermeable layer which protect the skin from UV radiation.

Stratum lucidum:

This layer consists of 2-3 layers, and is the clear layer of the skin, only found in thick skin areas of the body such as palms, soles, and fingerprints. The transparent nature of the layer is due to the presence of transparent keratinocytes.

Stratum granulosum :

This is 3-5 layers consists of granular cells which differentiated from spinous layer.

Stratum spinosum (prickle/spinous layer):

The section has 8-10 layers thick above the basal layer and consists of polyhedral shaped keratinocytes with cytoplasmic processes and referred as spines. They are also have dendrite cells in the layer.

Stratum basale/stratum germinativum (basal layer):

This is the deepest layer of epidermis and consists of a single layer of undifferentiated keratinocytes also known as basal cells. The basal cell is cuboidal shaped stem cell.

❖ **Dermis(Middle layer).**

Dermis is 3-5mm thick layer and is composed of a matrix of connective tissue, which contains blood vessels, lymph vessels, and nerves. The cutaneous blood supply has essential functions in regulation of body temperature. It also applicable nutrients and oxygen to the skin which removing toxins and waste products. Capillaries reach to within 0.2mm of skin surface and provide skin condition for most molecules penetrating the skin. The blood supply thus keeps the dermal concentration of permeate very low and low and the resulting concentration difference across the epidermis provides essential concentration gradient for transdermal permeation.

❖ **Hypodermis (Inner layer).**

The hypodermis or subcutaneous fat tissue supports the dermis and epidermis. It serves as a fat storage area. This layer help to regulate temperature, provides nutritional support and mechanical protection. It carries principal blood vessels and nerves to skin and may contain sensory pressure organs.

Different forms of skin wounds :



Wound healing activity:

A wound is a type of physical injury where the skin gets torn, cut, or pierced. When the wound is exposed to air, microorganisms can enter it, leading to contamination and eventually infection. This entire process is a reaction of the connective tissue. The first stage is an acute inflammatory response, which is followed by the production of collagen and other large molecules outside the cells that help in forming a scar. This

process starts as a reaction to an injury. The reason why plants are used is because they are safe, reliable, and have fewer side effects.

Classification of Wounds:

Wounds are classified as open wounds and closed wounds on the basis of the underlying cause of wound creation and as acute and chronic wounds on the basis of the physiology of wound healing.

A. Open wound :



Through the open wound, blood escapes the and bleeding is clearly visible.

1) Incised Wounds:

It is an injury with no tissue loss and minimal tissue damage. It is caused by a sharp object such as a knife. Bleeding in such cases can be profuse, so immediate action should be taken.

2) Laceration wound or tears wounds:

This is a nonsurgical injury in conjunction with some type of trauma, resulting in tissue injury and damage

3) Puncture wounds

They are caused by some object puncturing the skin, such as a needle or nail. Chances of infection in them are common because dirt can enter into depth of the wound.

4) Penetration Wounds:

Penetration wounds are caused by an object such as a knife entering and coming out from the skin

B. Closed wound:



In closed wound, blood escapes the circulating system but remains in the body. It includes contusion or bruises, hematomas or blood tumors, crush injury, etc.

1) Continues Or Bruises:

Barriers are caused by blunt force trauma that damages tissue under the skin.

2) Hematomas Or Blood Tumors:

They are caused by damage to a blood vessels that consequently causes blood to collect under the skin.

3) Crush Injury:

Crush injury is caused when a great or extreme amount of force is applied to the over a long period of time.

C. Acute Wound :



1) An acute wound is a tissue injury that normally proceeds through an orderly and timely reparative process that results in sustained restoration of anatomic and functional integrity.

2) It is usually caused by cuts or surgical incisions and the wound healing process within the expected time frame.

D.Chronic Wound :



Chronic wounds are wounds that have failed to progress through the normal stages of healing and therefore enter a stage of pathogenic inflammation.

HEALING OF WOUND :

Wound healing is a natural physiological process that usually occurs within 4 to 6 weeks through cellular regeneration and the action of blood clotting factors, even without external medication. However, chronic wounds fail to heal within this normal timeframe and often require

medicaments or therapeutic interventions to promote recovery. The healing process is complex and highly coordinated, involving multiple cellular and biochemical activities. It progresses through four overlapping but distinct phases: the haemostasis phase, which stops bleeding; the inflammation phase, which prevents infection; the proliferation phase, which forms new tissue; and the remodelling phase, which restores tissue integrity.

1. Haemostasis– This is the initial stage where blood clot formation takes place to stop bleeding and seal the injured site.

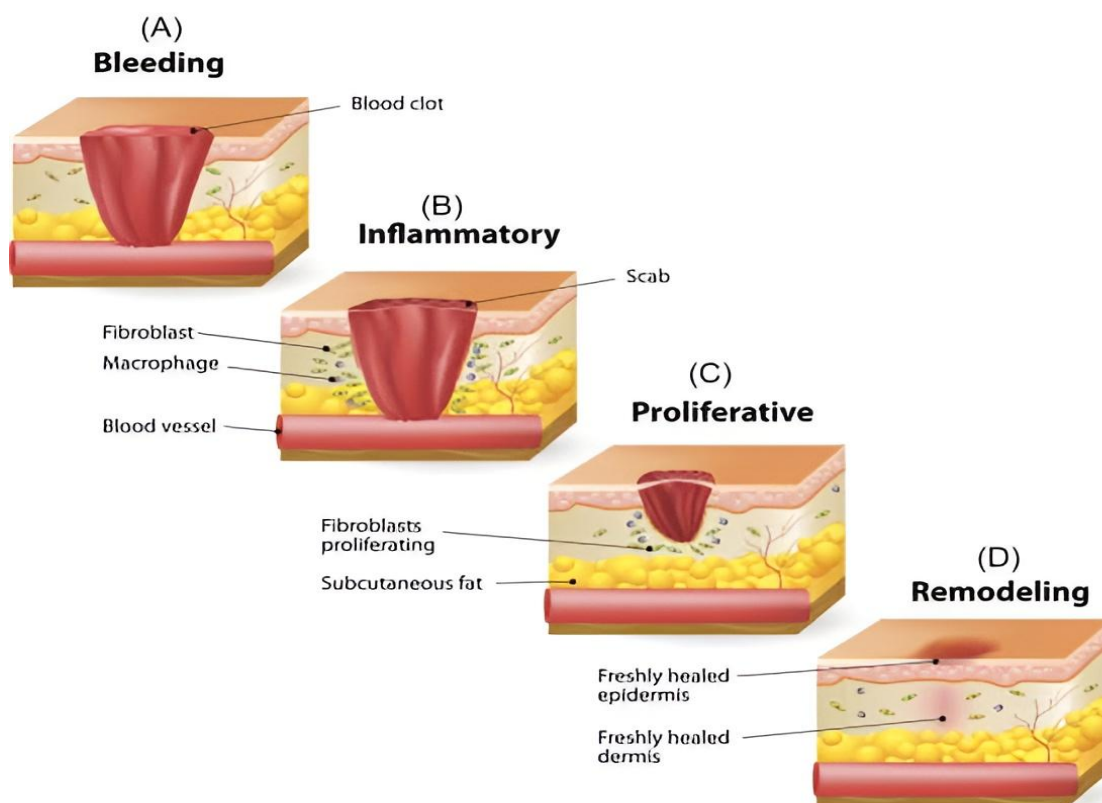
2. Inflammation –In this phase, the wound shows redness, swelling, warmth, and exudate as immune cells remove debris and prevent infection.

3. Proliferation– During this stage, various cells actively multiply, leading to the formation of granulation tissue and new blood vessels.

4. Remodelling (Maturation)– In the final stage, the wound closes completely, collagen is reorganized, and a scar is formed to restore skin integrity.

Stages of the wound healing process :

WOUND HEALING



DEVELOPMENT OF VARIOUS PHYTOMEDICINE FOR WOUND HEALING ACTIVITY:

Phytomedicines derived from medicinal plants have been widely recognized for their effectiveness in promoting wound healing on several types of wounds. These compounds are usually obtained from whole plants or specific explants through various extraction methods. Different plant parts, including leaves, stems, roots,

bark, flowers, and seeds, are rich in phytoconstituents that possess multiple therapeutic benefits. Medicinal plants naturally produce these bioactive molecules as secondary metabolites, which play essential roles in protecting them from microorganisms, insect attacks, and several diseases. Because of these phytomedicines are considered valuable agents in enhancing wound repair and supporting human health.

Aloe vera 	Biological name : Aloe vera	Parts of plant : Leaves	Types of wounds : Surgical wounds, diabetic foot ulcer and burns
	Family : Liliaceae		
	Phytomedicine : Glucomannans	Formulation : Ointment	
	Description : It aids the wound healing process by stimulating glycolytic enzyme activity and supplying energy required for cellular repair and restoration. ⁶		

	Biological name : Sambucusebulus L	Parts of plant : Leaves	Types of wounds : Incision and excision wounds
	Family : Adoxacea		
	Phytomedicine: : Quercetin 3-O-glucoside	Formulation : Ointment	
	Description :The wound healing effect of Sambucusebulus may be attributed to the synergistic action of phytomedicine present in its methanolic extract ⁷		

	Biological name : Quercusinfectoria	Parts of plant : Leaves	Types of wounds : Wound and burn
	Family : Fagaceae		
	Phytomedicine : Flavonoids and gallic acids	Formulation : Gel	
	Description : The wound healing efficacy of this plant is attributed to its modulation of antioxidant enzymes. ⁸		

Hyperciumpatulum	Biological name : Hyperciumpatulum	Parts of plant : Leaves	Types of wounds :
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	Family : Hypericaceae		Excision wound and incision
	Phytomedicine : Flavonoid, terpenoids and steroid	Formulation : Ointment	
	Description : Hypericum patulum is a medicinal shrub with antimicrobial, anti-inflammatory, and wound-healing properties, traditionally applied for cuts, burns, and ulcers. ⁹		

	Cinnamomum verum	Biological name : Cinnamomum verum	Parts of plant : Bark	Types of wounds : Cuts and infected wound
		Family : Lauraceae		
		Phytomedicine : Cinnamaldehyde and quercetin	Formulation : Cream and ointment	
Description : Cinnamomum verum promotes wound healing through antimicrobial, antioxidant, and anti-inflammatory actions, supporting tissue regeneration, reducing infection, and enhancing recovery naturally. ¹⁰				

	Catharanthus roseus	Biological name : Catharanthus roseus	Parts of plant : Leaf	Types of wounds : Diabetic wound
		Family : Apocynaceae		
		Phytomedicine : Hydroxyproline	Formulation : Gel	
Description : Hydroxyproline content contributes to wound healing and contraction by enhancing tensile strength. ¹¹				

Camellia sinensis	Biological name : Camellia sinensis	Parts of plant : Leaves and leaf bud	Types of wounds : Cuts
	Family : Theaceae		

	Phytomedicine : Catechin, phenolic compound and flavonoid	Formulation : Ointment
	Description : The ointment formulated from green tea extract exhibits wound healing activity in post-surgical wounds. ¹²	

	Matricaria recutita	Biological name : Matricaria recutita	Parts of plant : Dried flower	Types of wounds : Incision wounds, excision wounds, and dead space wounds
	Family : asteraceae			
	Phytomedicine : Hydroxyproline	Formulation : Gel		
	Description : hydroxyproline content supports the use of Matricaria recutita in promoting wound healing. ¹³			

	Cinnamomum zeylanicum	Biological name : Cinnamomum zeylanicum	Parts of plant : Bark	Types of wounds : Incision wound, dead space wounds
	Family : Lauraceae			
	Phytomedicine : Volatile oil contain cinnamic aldehyde. Eugenol and terpenes.	Formulation : Gel		
	Description : The ethanolic extract promotes key phases of healing, including collagen formation, wound contraction, and epithelialization. ¹⁴			

Curcuma longa	Biological name : Curcuma longa	Parts of plant : Rhizome (root)	Types of wounds :
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	Family : Zingiberaceae		Wounds, cuts and burns
	Phytomedicine : Curcumin and curcuminoid	Formulation : Nanoparticles	
	Description : Curcumin exerts a potent effect on wound healing and shortens the overall healing time. ¹⁵		

	Chloroxylonswietenia		
	Biological name : Chloroxylonswietenia	Parts of plant : Leaves	Types of wounds : Excision wounds
	Family : Rutaceae		
	Phytomedicine : Alpha pinene, sabinene and octan	Formulation : Ointment	
	Description : Phytomedicinal compounds play a supportive role in the wound healing process. ¹⁶		

	Achillea millefolium		
	Biological name : Achillea millefolium	Parts of plant : Flower	Types of wounds : Ulcer and chronic wounds, burises
	Family : asteraceae		
	Phytomedicine : Essential oil and hydrosol	Formulation : Ointment	
	Description : Achillea millefolium (yarrow) is a medicinal herb with hemostatic, antimicrobial, and anti-inflammatory properties, traditionally used for wound healing. ¹⁷		

Indian fig , prickly pear	Biological name : Indian fig , prickly pear	Parts of plant : Fruit and seed	Types of wounds : Diabetic wounds, chronic ulcer and brun
	Family : cactaceae		

			wounds
	Phytomedicine : Alpha linolenic acid, quercetin and flavonoid	Formulation : Ointment ,cream and gel	
	Description : Opuntiaficus-indica (Indian fig) is a cactus with soothing, antimicrobial, and regenerative properties, traditionally used for burns and wounds. ¹⁸		

	Biological name : Arctiumlappa		Parts of plant : Leaves	Types of wounds : Ulcer , Festering wounds
	Family : Asteraceae			
	Phytomedicine : Tannins, phenolic acids,Essential oils and flavonoids.		Formulation : Ointment	
	Description : Arctiumlappa possesses bioactive compounds with antioxidant and anti-inflammatory properties, accelerating wound healing through collagen synthesis and tissue regeneration. ¹⁹			

	Lycopodiumcalvatumlinn	Biological name : Lycopodiumcalvatumlinn	Parts of plant : Aerial parts	Types of wounds : Burns and ulcer wounds
		Family : Lycopodiaceae		
		Phytomedicine : Coumaric acids, ferulic acid terpenoids and flavonoids	Formulation : Ointment and cream	
		Description : Lycopodiumclavatum is a medicinal club moss whose spores aid wound healing by stopping bleeding, preventing infection, and supporting chronic ulcer recovery. ²⁰		

Zizphus oenoplia	Biological name : Zizphus oenoplia	Parts of plant : Leave	Types of wounds : Infected wounds , cuts and fresh
	Family : Rhamnaceae		

			wounds
	Phytomedicine : Pentacyclitriterpenes, phenol and flavonoids	Formulation : Ointment	
	Description : Ziziphusenoplia is a medicinal shrub with antimicrobial and anti-inflammatory properties, traditionally applied as paste or decoction for wound healing. ²¹		

	Carica papaya		
	Biological name : Carica papaya	Parts of plant : Leaves	Types of wounds : Infected wounds, diabetic wounds and bedsores
	Family : Cariaceae		
	Phytomedicine : Quinones, coumarins, cyanogenic flavonoid, phenol.	Formulation : Ointment ,cream and gel	
Description : Carica papaya aids wound healing through papain enzyme, antimicrobial and anti-inflammatory actions, traditionally applied to burns, ulcers, cuts, and infected wounds. ²²			

	Sidaacuta		
	Biological name : Sidaacuta	Parts of plant : Flower	Types of wounds : Chronic , non-healing wounds and burns , cuts
	Family : Malvaceae		
	Phytomedicine : Tanins alpha amylase flavonoids	Formulation : Ointment and cream	
Description : Sidaacuta promotes wound healing through antimicrobial, anti-inflammatory, and regenerative actions, traditionally applied as paste, decoction, or oil for cuts and ulcers. ²³			

II. CONCLUSION :

Medicinal plants are those which contain the many phytomedicines it deals with a number of diseases and which are resolved. These medicinal

plants are used Traditionally among tribal people. Extracts are obtained through several methods such as Soxhlet extraction, percolation, maceration, and decoction that serve as the foundation for

developing modern formulations, including ointments, gels, nanoemulsions, and others. These formulations are further evaluated to ensure their efficacy, safety, and potential for both clinical and therapeutic application. Many medicinal plants are proven to show the wound healing activities, from that we had investigated about some of them such as Aloe vera, sambucusebulus L, Quercusinfectoria, Hypericum patulum, Cinnamomum verum, catharanthus roseus, camellia sinensis, Matricaria recutita, Cinnamomum zeylanicum, Curcuma longa, Chloroxylon swietenia, Achillea millefolium, Indian fig, (Prickly pear), Arctium lappa, Ziziphora oenoplia, Carica papaya and Sida acuta. The goal of this review is to explore medicinal plants about the phytomedicinal property with their activities on several wound healing process. The report gathered from the referenced studies highlights the diverse biological activities of these compounds, supporting their potential as effective agents in wound management.

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