

To formulate and evaluate polyherbal gel containing Terminalia arjuna and Aloe vera extracts for potential burning wound management

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Abstract: Wound curing is a slow and complex method that develops even more difficult in burn injuries due to pain, inflammation, and high probabilities of infection. Several chemical-based medicines used for wound care can cause side effects or may not work effectively in all cases. Because of this, herbal medicines are attractively popular as safer and more reasonable options. This review focuses on two important medicinal plants Terminalia arjuna and Aloe vera which have continued widely used in outmoded systems for treating injuries and skin problems. Terminalia arjuna contains tannins and antioxidants that help decrease wound size, protect tissues, and recover collagen formation. Aloe vera is known for its cooling, calming, and nourishing action. It supports new skin formation, reduces pain and redness, and increases the strength of healed tissue. This review highlights how these three herbs individually support different stages of wound healing and how their combination may provide stronger and faster recovery due to their complementary actions. Based on the available studies, polyherbal formulations containing Arjuna and Aloe vera show great potential as effective and natural alternatives for wound and burn treatment. Polyherbal formulations are broadly used in traditional systems of treatment like ayurveda for wound curing. Flavonoids, triterpenoids and tannins existing in the polyherbal gel and their cooperative action may be responsible for better wound healing activity. The conserved injuries showed a high rate of wound narrowing linked with controls and the wound contractions enlarged with an increase in herbal extract absorption. Due to development of modern system of medication like nanotechnology based polyherb-preparation are predominately have enhanced capability to treat problems of body in comparison to traditional medication system. Wounds healing should be treated by using polyherbal combination which shows synergetic effect and show better healing and shows less adverse effects. By combining this herbal formulation, it advanced novel drug delivery system and it should be more focused to drug delivery site.

Index Term – Burn injuries, polyherbal gel, Herbal extract, Terminalia Arjuna, Aloe vera

INTRODUCTION

Burns are some of the greatest severe and painful wounds, frequently impacting children, individual with incapacities, and the elderly, whose population is growing in aging societies.(1) Burn are the fourth most common injury recorded after road accidents, falls and shock.(2) by the change climate and increasing temperatures, sunburns, which are related with a variety of skin cancers with melanoma, are also being popular.(3) A burn occurs when external factors such as heat, chemicals, or electricity damage the skin and break its protective barrier. Once the skin's integrity is impaired, its normal functions are disrupted, increasing the risk of dehydration, infection, metabolic imbalance, and in severe cases, death.(4,5)

Burn injuries are still considered major medical emergencies that disturb people of all ages and sexes across both developed and developing nations. These injuries often result in enduring physical harm, emotional trauma, and, in many cases, permanent disability.(6)

Wound healing takes place through three key stages. The initial inflammatory phase includes coagulation, the release of cytokines, chemotaxis, and the recruitment of various cells. The next stage, known as proliferation, involves the restoration of dermal tissue through angiogenesis and fibroplasia. The final maturation phase focuses on the re-modelling and strengthening of the extracellular matrix.(7)

A burn are caused by direct contact among the skin and a heat source.(8) Mainly burn injury can be caused by high temperature, electricity, friction and chemicals .(9) Burn damages differ in extent, and when a larger area of the body is affected, the chances of wound-related complications and patient mortality increase significantly.(10)The severity of a burn injury is significantly influenced by factors such as the burn location, the temperature of the heat source, and the duration of exposure, which interact synergistically.(11)

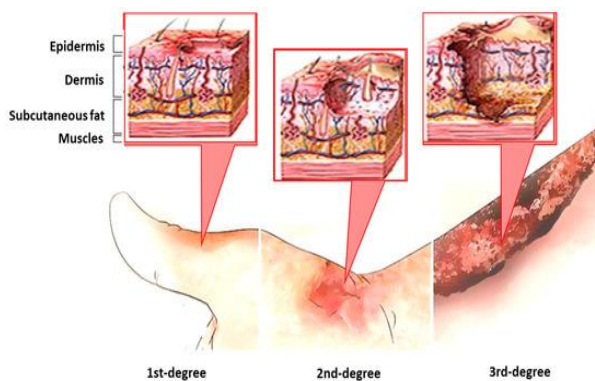


Figure. 1 Burning wound (12)

Herbal based medicines are very helpful for treat many diseases in India.(13) One of the surveys showed by the WHO reports that more than 80% of the world's population still depends upon the traditional medicines for various diseases. In the developed countries 25 percent of the medical drugs are based on plants and their derivatives and the use of medicinal plants is well known among the indigenous people in rural areas of many developing countries.(14) Study shows that in North America, burn injury is one of the main causes of injury deaths, particularly in children under the age of 14 years.(15)

According to the U.S. National Center for Injury Prevention and Control, around 2 million fires are reported each year, resulting in about 1.2 million burn injuries.(16) In wound care, herbal remedies promote disinfection, aid debridement, and sustain a moist environment, thereby supporting the body's innate healing mechanisms.(13)

WOUND HEALING

Wound classification is crucial for effective management and diagnosis, as it guides the selection of appropriate treatment, helps estimate the required healing time, and allows clinicians to anticipate potential risks and complications that may arise during the healing process.(17) The wound healing is classified into three types based on the how human skin repairs damage primary intention, secondary intention and tertiary intention, where main intention means fast closing of wounds, minor intent means slow closing of the clean and tertiary purpose means delayed closing of the wound. There are 3 types of wound healing

1. Primary healing: it is used for clean, uninfected wound with minimum tissue loss, such as surgical incision
2. Secondary healing: it occurs when a wound has significant tissue loss, infection or edges that cannot be opposed. This process takes longer and result in more scar tissue.
3. Tertiary healing: it is the combination of both primary and secondary healing process, where a wound is purposely left opened to allow infection or contamination to decrease often for 4-6 days before being closed surgically. This often used for infected or traumatic wounds.(18)

SCOPE AND LIMITATION

It is well known that herbal remedies are used to treat several diseases, including wounds, cuts and burns. In comparison to the standard treatment available for wound healing, herbal treatments show fewer side effects. Also, polyherbal preparations provide safe and cost- effective option for wound management. Polyherbal gels which are widely used in topical formulation for wound healing and burn healing. These formulation combine multiple herbal extracts, which provide synergetic therapeutic effect such as antimicrobial and anti-oxidant properties.(19)**Synergistic therapeutic efficacy**

By combining herbs, polyherbal gels makes greater wound healing contraction and epithelialization rates as compare to individual herbal application, often reaching wound contraction

Multi-target mechanism : They have multiple pathways like antimicrobial, anti-inflammatory and angiogenic. The gel base delivers a saturated atmosphere necessary for optimum healing and prevent the wound from drying out and adhering to dressing material.(20)

Limitation

Limited Clinical Trial Evidence: While many formulations shows that high efficacy in preclinical studies, severe, large-scales human clinical trials are sparse, with the deviation of specific agent like aloe vera.

In-effectiveness on severe burns: Polyherbal gels are primarily effective for first and second-degree burns. Their efficacy on severe, third degree, or infected deep burns is limited and often not fully established in studies.

Risk of Allergy: Despite generally being safe, individual components or contaminated they may cause skin irritation or allergic reaction in sensitive patients.(21)

TERMINALIA ARJUNA

Terminalia arjuna belongs to a family Combretaceae is a common Plant found universally in India and generally known as Arjuna. Leaves must be provide septic and quick healing effect to cure diseases.(22) *Terminalia arjuna* is rich in bioactive constituents that contribute to its medicinal value. Among these, tannins play a major role by offering against oxidant and anti-inflammatory effects. They help in the healing of burn wounds through their against microbial, antioxidant, and anti-inflammatory activities, which regulate the wound environment and promote the skin's natural regeneration process.(23)

Terminalia arjuna bark is rich in bioactive constituents like flavonoids, tannins, triterpenoids, and phenolics, which deliver strong antioxidant, anti-inflammatory, and antimicrobial effects(24). These properties are especially important in burn wound healing, where oxidative stress, microbial contamination, and persistent inflammation can slow down tissue repair. Research has shown that *Terminalia arjuna* exhibits substantial wound healing activity by promoting collagen deposition, improving tensile strength, and speeding up epithelialization, which collectively support more rapid regeneration of injured skin.(25)

Furthermore, the elevated tannin levels promote astringent effects that support wound contraction and minimize exudation. Its phenolic compounds' against oxidant properties neutralize free radicals produced in burn injuries, protecting tissues from harm and encouraging recovery.(26) The wound healing effects of *Terminalia arjuna* are accredited to its active compounds, which boost up the healing process and rise the strength of the restored tissue. Likewise, wound healing was more effective with a polyherbal formulation compared to treatment with ageratum alone in rats. This enhanced effect is likely due to the combined, synergistic actions of ageratum and the other plant constituents included in the polyherbal mixture.(27) The herb progresses wound healing by supporting collagen remodelling, which is energetic for skin repair. In traditional practice, the powdered bark is applied directly to the wound to optimize healing. Tannins derived from the bark have been shown to markedly reduce wound area and increase tissue tensile strength, with the extent of benefit observed to correlate with the concentration of tannins.(28) *Terminalia arjuna* is considered a valuable natural plant source that demonstrations strong potential as antioxidant activity and for curing wounds.(29)

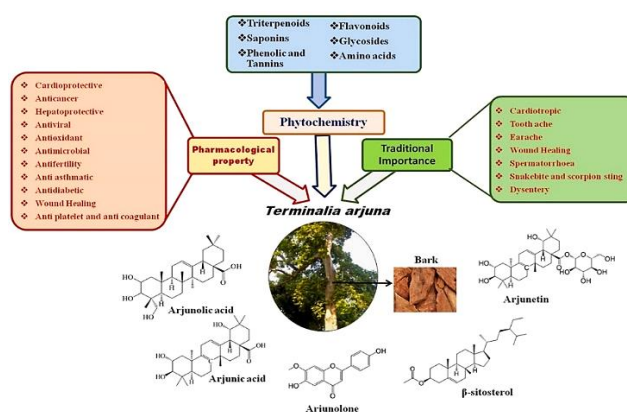


Fig. 2 Terminalia Arjuna(30)

ALOE VERA

Aloe vera is a perennial moist of the Liliaceae family, is commonly mentioned to as a healing plant and has been conventionally used in folk medicine. In vitro evidence shows that Aloe vera extracts or their chemical constituents stimulate the growth of multiple cell types. Several studies have reported that treatment with whole Aloe vera gel or its extracts leads to faster wound healing.(31) Aloe vera extracts are widely used in healthcare, skincare, and medical products as active ingredients for non-therapeutic, hygienic, refreshing, and general health-supporting purposes. The plant's bioactive constituents possess potential antibacterial, anti-inflammatory, and antioxidant properties that can aid in the treatment of burn wounds.(32)

Aloe vera is widely recognized for its soothing and healing effects on burns and other types of wounds. When applied topically, it enhances the rate of wound closure and improves wound tensile strength by promoting cellular proliferation.(33)

Aloe vera is often referred to as the "burn plant" and is commonly used in the management of burn wounds. In aloe vera 75 different compounds are identified in which 20 minerals, 20 amino acids, various vitamins, and water.(34)

Aloe vera gel generally used to make topical medicines for skin environments such as burns injuries and other topical drugs. Aloe Vera has a cooling property which helps to recover burned skin. Aloe vera is commonly used in burn management due to its soothing, moisturizing, and healing qualities. It aids in reducing pain, inflammation, and accelerates skin repair and the process of skin regrowth over wounds. Studies indicate that aloe vera can be effectively combined with other herbal ingredients like *Terminalia arjuna* for synergistic wound healing benefits.(35) The growing attention in natural and herbal medicines, along with the easy accessibility of raw materials, low production costs, and minimal reports of adverse effects, encouraged the development of a polyherbal topical formulation to evaluate its wound-healing potential.(36)

Herbal medicine is so helpful for curing diseases that about 80% of world population is depend on it for good and effective healing. Herbal product contains various chemical compound which are helpful or used to cure chronic and infectious

diseases.(37) The gel extracted from the inner parts of Aloe vera leaves, rich in polysaccharides like acemannan and glucomannan, is considered responsible for many of its therapeutic benefits, including accelerated wound curing and skin renewal. Several preclinical and clinical report have supported the efficiency of topical formulation. Aloe vera in the healing of various skin injuries, including burns, surgical incisions.(38,39)



Fig no. 3 Aloe Vera(40)

KEY FEATURES OR THEMES

The key themes of this review article focus on the beneficial probable of healing plants in the handling of burn wounds, mainly *Terminalia arjuna* and *Aloe vera*. Burn injuries require active treatment to accelerate healing, prevent infection, and reduce damaging. Herbal medicines have expanded attention due to their natural origin, safety, and multiple pharmacological properties. This review highlights the phytochemical constituents present in these plants, such as flavonoids, tannins, and polysaccharides, which subsidize to antioxidant, against inflammatory, and against microbial activities. It also converses the role of polyherbal gel formulations in improving wound healing through greater collagen synthesis, tissue regeneration, and moisture retaining. Furthermore, the article summarizes current research findings and emphasizes the potential of these herbal agents in developing effective burn wound healing therapies and provide skin soothing and less irritation.(41–43)

ADVANTAGES OF POLYHERBAL GEL

Synergistic action: By combining herbs allows for a multi-targeted approach, with combining antimicrobial, anti-inflammatory, and anti-oxidant effect in single formulation which helps in burning wound.

Faster Healing: Previous studies show that polyherbal gel accelerated burn wound closure and better skin regeneration as compared to single herbal gels.

Reduced side effects: Polyherbal formulation often exhibit lower cytotoxicity and fewer adverse effect as compared to conventional synthetic agents like silver sulfadiazine which can sometimes delays healing.

Cost effective: The raw material is easily available and inexpensive, and making them a lower cost alternative for long term treatment of burn wound.(44)

DISADVANTAGES OF POLYHERBAL GEL

Organoleptic Properties: Some patients may rate the colour, odour and stability of natural herbal gels lesser that conventional synthetic preparations.

Standardization issues: Sometimes it is hard to standardize the concentration of active components in herbal preparations.

Microbial risk: The high-water content in some gel formulations increases the risk of microbial or fungal contamination.

Stickiness: Gels can be sticky in some cases that cause discomfort to the user.(45)

BENEFITS OF TERMINALIA ARJUNA:

1. Higher concentration of tannins
2. Antibacterial properties
3. Wound contraction properties
4. Tissue Regeneration

BENEFITS OF ALOE VERA:

1. Ability to reduce inflammation
2. Inhibit pain, faster healing

3. New skin formation

4. Anti-inflammatory, antioxidant and antibacterial properties

METHODOLOGY

Terminalia arjuna extract preparation

Healthy, disease-free bark from *Terminalia arjuna* plants was carefully collected and taxonomically authenticated. The bark was cut into small fragments and shade-dried for 10–15 days. After air drying at room temperature, it was ground into a fine powder under sanitized conditions.

To prepare the aqueous extract, 3 g of *Terminalia arjuna* powder was accurately weighed and dispersed in 100 mL of distilled water. The suspension was then gently boiled on a heating mantle maintained at 60–70°C for 20 minutes. The resulting extract was filtered using Whatman No. 1 filter paper to obtain a clear filtrate suitable for ZnO NPs synthesis.(46)

Aloe vera gel extract preparation

Firstly, aloe vera plant were collected, and then plant is washed properly with water and shade dried and then converted in to fine powder. After that absolute ethanol was added in to double the volume of the powder. Then mixture should be continuous stirring for a while and then mixture have to store for 24 hours, followed by filtration. An equal volume of ethanol was then added to the residue, and this extraction process was repeated twice. By combination of three filtrates were combined and ethanol present in it was evaporated at room temperature to yield a concentrated Aloe vera extract (0.5%). The powdered extract was subsequently redissolved in double-distilled water.(47)

Method of preparation of polyherbal gel of terminalia arjuna and aloe vera

Carbopol 934 (1g) was dispersed in 50 mL of distilled water with continuous stirring and avoid lumping. Separately, 5 mL of distilled water was heated on a water bath to dissolve the required amounts of methylparaben and propylparaben. After cooling, the solutions propylene glycol 400 was combined into this solution. The specified quantities of *Terminalia arjuna* and Aloe vera extracts were added to the solution and the volume was adjusted to 100 mL with the remaining distilled water. This mixture was thoroughly combined with the Carbopol 934 dispersion with constant stirring. Triethanolamine was added dropwise to neutralize the gel, achieving the desired skin pH (6.8–7) and consistency. The control gel was prepared using the same procedure, neglecting the *Terminalia arjuna* and Aloe vera extracts.(48)

PRE-FORMULATION STUDY OF HERBAL EXTRACTS

Pre-formulation studies form the foundation of pharmaceutical formulation development by generating essential information needed to design a safe, stable, and effective dosage form. These studies focus on empathetic the basic physicochemical and compatibility characteristics of active substances before formulation work begins.

CHARACTERIZATION OF HERBAL EXTRACTS:

1.Organoleptic evaluation:

In organoleptic evaluation the combined extract of terminalia arjuna and aloe vera in which we experienced organoleptic assessment of colour, odour and appearance of the products should be identified.(49)

2.Preliminary evaluation:

The initial analysis of combined extracts established their latent for dermal application, based on solubility patterns, physical appearance, and freedom from observable impurities, supporting subsequent development stages.(50)

3.Solubility study:

Solubility valuation serves as a key factor in phytoconstituent investigation, directly affecting drug absorption and bioavailability. *Terminalia arjuna* extract establishes strong solubility in polar solvents like water and ethanol, due to presence of tannins and glycosides in extracts. Aloe vera gel, rich in polysaccharides, shows excellent solubility in aqueous media.(51)

4.Ph determination:

The predictable pH range of the product must be 5.5–6.8 slightly acidic to near neutral. This range minimizes skin disruption and supports healing.

5.Drug–excipient compatibility study:

Drug-Drug and drug excipient compatibility studies of the combined herbal extracts indicated no significant physical or chemical interactions, studies signifying that the extracts can be safely combined together in a stable polyherbal gel system.(52)

6. Moisture content:

The moisture content of herbal drugs is a serious quality control parameter affecting stability and microbial growth; Terminalia arjuna bark typically contains moderate moisture levels within pharmacopeial limits and aloe vera possesses a very high natural moisture content, that it require proper drying or stabilization to prevent degradation.(53)

7. Stability studies:

The combined herbal extracts maintained acceptable physical and chemical stability during storage under controlled conditions, protected against light exposure and contamination, which supports their incorporation into polyherbal gel formulations.(54)

EVALUATION OF POLYHERBAL GEL:

1. Physicochemical evaluation of the formulated polyherbal gel

It was observed that the freshly prepared formulations were off white to yellow in colour. Regarding the base and formulation, A, B and C, there was no change in colour, odour and appearance up to the observation period of 30 days at 80-40 degree Celsius using different storage conditions, also the Formulations A, B and C were stable.(55)

2. Prepared formulations ph

The pH of the polyherbal gel formulation was measured using a calibrated pH meter at 1, 30, 60 and 90days post-preparation to assess stability over time. Values remained within the optimal range of 5.5–6.5, ideal for topical use as it aligns closely with the skin's natural pH. (56)

3. Viscosity test

Herbal gel samples were balanced at room temperature for 30 minutes. Viscosity was then determined using a Brookfield viscometer prepared with spindle No. 7, operating at 200 rpm.(57)

4. Spreadability

The spreadability test evaluates the gel's extensibility upon skin application. It involved marking a 7.5 cm circle on one glass slide, placing 1.0 g of the prepared gel at its center, and positioning a second slide on top. A 100 g weight was applied to the upper slide for 60 seconds, after which the diameter of the spread gel was measured using a scale. The procedure was repeated three times per formulation, with means calculated, and spreadability determined using the standard formula.(58)

Formula $S = M \times L / T$

Where,

S, determine spreadability

M, determine weight tide to the upper slide

L, determine length of glass slide

T, determine time taken to separate the slides.(59)

COMPARATIVE ANALYSIS

Studies shows that bark extract of Terminalia arjuna accelerate wound contraction and epithelialization. The presence of tannins provides an astringent effect that helps in tissue repair and prevents microbial invasion in burn wounds. Flavanoids and triterpenoids exhibit strong antioxidant activity that protect damaged skin from oxidative stress.

Aloe vera gel is widely used in burn wound treatment due to its soothing and moisturizing assets. Polysaccharides such as acemannan stimulate fibroblast proliferation and collagen synthesis, which enhance skin regeneration. Anti-inflammatory compounds present in aloe vera reduce pain and swelling.

Market available formulation used for burning wound

Patanjali aloe vera gel – commonly used for minor burns and skin irritation

Khadi natural aloe gel – used for soothing burn wounds and sunburns

Himalaya antiseptic cream – They are uses for burns, cuts and skin infection

Vicco turmeric skin cream – It contains herbal ingredients with antimicrobial and wound healing properties.

While seeing these formulations they are useful for minor burns and they are used in single combination while we combine them then their antioxidant and antimicrobial mechanism improve tissue strength and wound contraction. They also provide soothing effect for skin through which skin can be cured properly without any irritation and they could offer an effective and natural approach for burn wound management.(60–62)

IMPLICATION AND RELEVANCE

Synergistic Action: Combining multiple herbs regularly results in superior therapeutic efficacy compared to single-herb treatments, as the compounds act on multiple targets instantaneously.

Enhanced Safety Profile: Polyherbal gels generally offer a lower risk of allergic reactions, skin irritation, or toxicity, making them right for long-term use.

Improved Patient Compliance: The gel formulation delivers a non-greasy, non-staining, and easily washable application, which is ideal for treating large, hairy, or sensitive areas.

Targeted Delivery & Stability: Gels allow for sustained drug release at the site of infection and provide high moisture holding, which accelerates tissue regeneration, reduces inflammation, and improves wound contraction.

Overcoming Microbial Resistance: The multi-constituent nature of polyherbal gels can help reduce the development of struggle in bacteria, which is a common problem of conventional antibiotics.(63)

RELEVANCE:

Wound Healing & Burn Care: Polyherbal gels are highly effective in promoting faster wound closure, reducing microbial load, and enhancing collagen synthesis in wound and burn models.

Acne Treatment: Formulations show significant antimicrobial activity against acnes and anti-inflammatory properties, offering a natural alternative to benzoyl peroxide.(64)

AREAS FOR FURTHER STUDY

Supplementary research should also include optimization of polyherbal gel formulations, stability studies, and advanced characterization of bioactive compounds responsible for therapeutic activity. In addition, in-vivo and clinical studies are necessary to confirm safety, efficacy, and dosage standardization. Development of novel delivery systems such as nano-gels or bioactive dressings incorporating these herbal extracts may further enhance burn wound healing outcomes. Future studies should focus on detailed pharmacological evaluation of polyherbal formulations having *Terminalia arjuna* and *Aloe vera* for burn wound healing. While both plants possess important antioxidant, anti-inflammatory, and antimicrobial properties, more orderly investigations are required to determine their synergistic mechanisms in wound repair.(65–67)

FINAL EVALUATION

Based on the existing literature, both *Terminalia arjuna* and *Aloe vera* reveal significant therapeutic possible in burn wound healing due to their antioxidant, anti-inflammatory, antimicrobial, and tissue-regenerating assets. These medicinal plants improve faster wound contraction, collagen synthesis, and epithelialization, which are vital for effective in burn recovery. The combination of these herbal extracts into polyherbal gel formulations may boost their synergistic effects and improve topical drug delivery. Still, further experimental studies, formulation optimization, and clinical trials are suggested to validate their safety, efficacy, and consistent dosage for large-scale therapeutic use in burn wound management.(68,69)

CONCLUSION

Further studies shows that medicinal plants *Terminalia arjuna* and *aloe vera* show significant probable in injury wound healing due to their antioxidant, anti-inflammatory, and antimicrobial properties. *Aloe vera* promotes faster epithelialization, maintains moisture, and reduce inflammation, while *Terminalia arjuna* enhances wound contraction and tissue regeneration through its rich phytochemical content. Their combined use in polyherbal formulation may produce synergistic effect that improve the burn healing process. However, further standardized studies and scientific trials are essential to authorize their safety, effectiveness, and optimal therapeutic application in burn wound management.

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