

# Natural Plant-Derived Interventions in Burn Wound Healing: Mechanistic Insights

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## **Abstract:**

Burn injury causes structural and functional damage to tissues which remain the major global health issue as thousands of cases are reported annually. Conventional treatment including silver nitrate, silver sulfadiazine, mafenide and other antibiotics which are used topically have some adverse effects such as hypersensitivity, scar formation and incomplete healing which make treatment less effective. As a result, more attention was shifted towards the use of herbal remedies which offers potential healing property. This literature mainly focuses on therapeutic potential of aloe-vera, *Chenopodium album*, *Praecitrullus fistulosus* in burn management. These plants are rich in phytochemical constituents which posse's anti-inflammatory, anti-oxidant and wound healing properties. The extract of these plants contains terpenoids, tannins, flavonoids and phenolic compounds which are responsible for accelerating burn wound healing, enhance tissue repair and reduce oxidative stress. The burn cream which can formulated using these herbal plants is a beneficial alternative to conventional burn treatment. The discussion shows the effectiveness of this herbal ingredients in burn treatment hence it shows fewer side effects compare to synthetic burn cream.

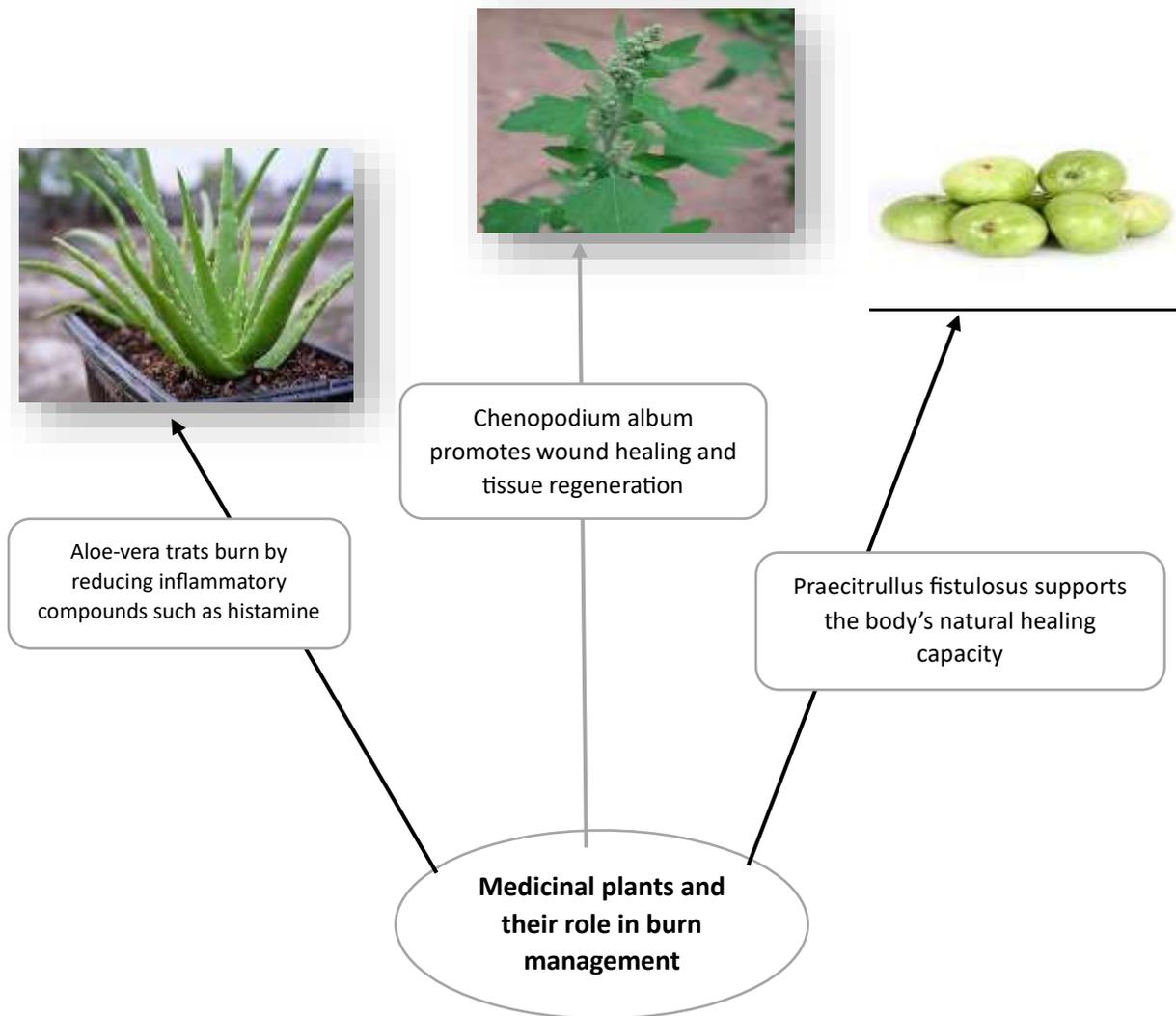
**KEYWORDS:** Burn wound, aloe-vera *Chenopodium album*, *praecitrullus fistulosus*

## **1. INTRODUCTION:**

Burn is defined as the destruction of the structure and functional process of tissue by high temperature, electric shocks or exposure to chemicals. According to American burn Association (2015) there are 486,000 cases of burn and in addition 3,240 deaths occurs annually because of burn. So, burn injury become most devastating of all injury and major global public health crises. (1) Based on depth of injury burn is classified into four degrees such as: First degree (superficial burn) which involve burning of skin's outermost layer (epidermis), second degree (partial thickness burns) involves dermis and epidermis portion burning, third degree (full thickness burns) in which burn might penetrate to deepest layer of skin and fourth degree burn which affect underlying tissue as well as deeper tissue. (2)

Burn injury to the skin causes the impairment of physiological barrier layer of skin which is important for protection from foreign microorganism. Therefore, it is important to manage burn injury. Antibiotic therapy is most commonly used approach for treatment of burn wound. Silver sulfadiazine is mostly used topical antibiotics for burn treatment but it has some limitations including black scar formation, hypersensitivity, incomplete epithelialization, etc. Mafenide acetate and silver nitrate are the other topical antibiotics which also have some side-effects. Therefore, researchers are tried to achieve proper treatment method which can have reduced side effect, so now a days focus has been shifted toward using herbal ingredient for management of burn. (3)

Herbal ingredients have been used by humans from decades many plants and their extracts have potential for treatment and managements of burn wounds *Chenopodium album*, *praecitrullus fistulosus*, aloe vera and many more herbal extracts are used for formulation of herbal cream for burn treatment these medicinal plants exhibit massive healing property (4).



### 1.1. Pathophysiology of burn wound:

Many factors are there which causes burn injuries such as high temperature, electricity, radiation, exposure to heat source and chemicals. 90% of all burn are thermal injuries and less than 5% of burn are electrical injuries which are most common in children and male manual workers.

Major burn injuries have both local and systemic effects (5). The three zones of burn were described by Jackson in 1947:

- I. Zone of coagulation: where irreversible tissue damage occurs during burn injury
- II. Zone of stasis: It is surrounding the zone of coagulation characterized by ischemia due to microvascular damage. This zone has effective burn resuscitation and wound care aim to salvage.
- III. Zone of hyperaemia: It is an outermost area, characterized by increased blood flow. It is a least damaged region with high chances of full recovery (6).

Burn injury causes release of cytokines such as TNF-2, interleukin-1 (IL-1) and IL-6 which trigger both local and systemic effect. Additionally mast cell, histamine and prostaglandin (PGD2, PGE2, PGI2) are also activated because of tissue trauma. This activation causes vasodilation which promotes oxygen delivery to damaged tissues and increases vascular permeability. Increased vascular permeability causes swelling that is characteristics of burn injuries (7).

Pathophysiology of burn injury

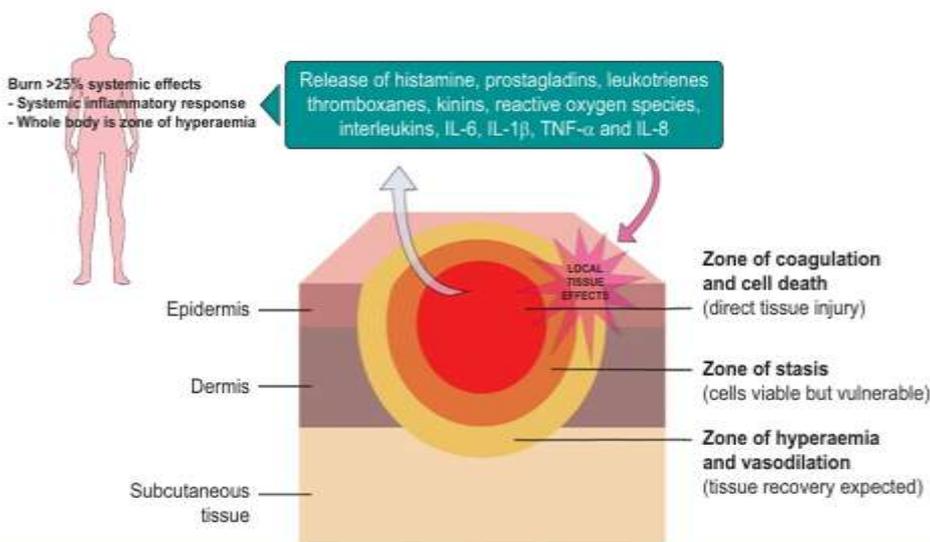
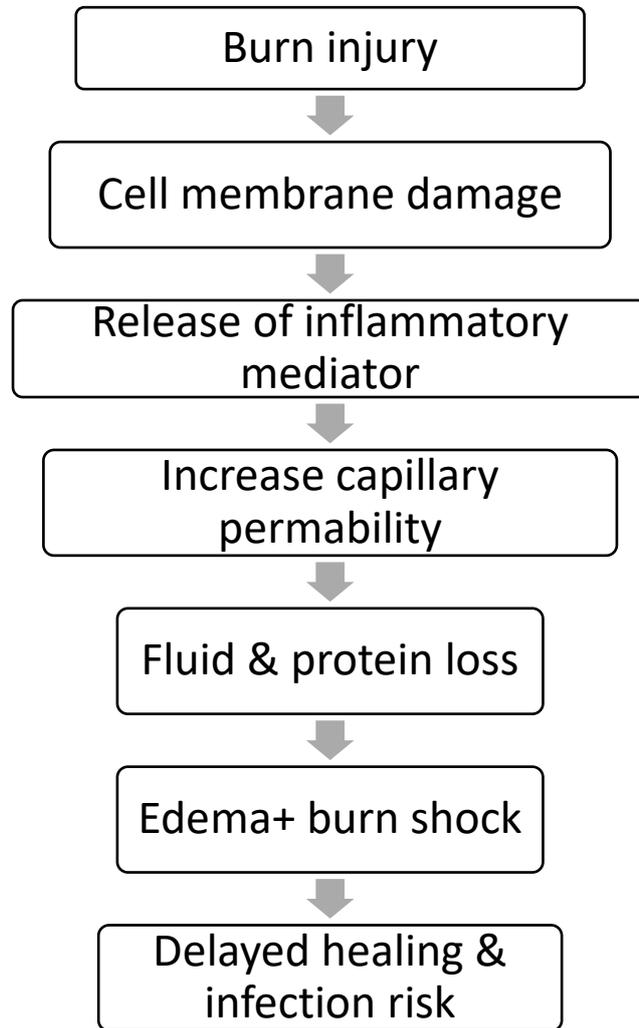


Fig. Pathophysiology of local burn injury (8)

### 1.2 Mechanism of burn wound healing:

The process involves four phases- Homeostasis, inflammation, granulation tissue hyperplasia and re-epithelialization. The mechanism phases are shown below

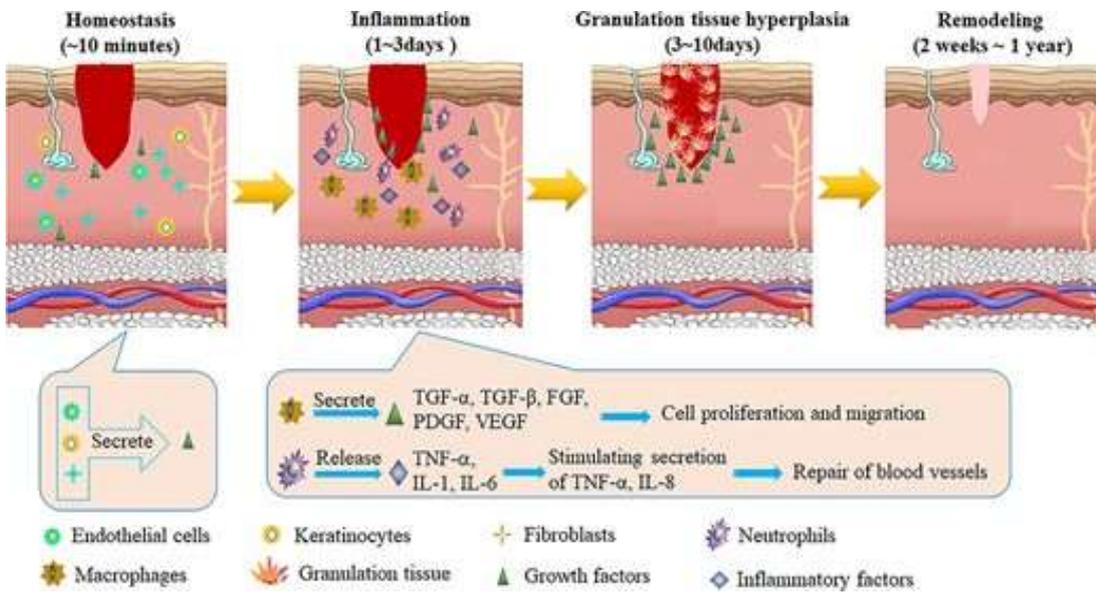


Fig. The mechanism involved in burn wound healing (9)

## 2. PLANT DISCRPTION

### ➤ Aloe-vera:

Aloe vera is a perennial succulent that belongs to Liliaceae family which is one of the oldest medicinal substances that are used in management of burn wound. It has potential effect against inflammation it has greater efficacy as compare to silver sulfadiazine cream for treating burn. (10) Aloe vera contain some polysaccharides, pectic acid or glucomannans which have wound healing properties, immune-stimulatory, antimicrobial and antioxidant properties, so it is widely used therapeutic herbs. Aloe vera also contain enzymes such as bradykinase, carboxypeptidase which have significant anti-inflammatory effects. Some studies revealed that burn wounds treated with aloe vera healed promptly and considered as the main factors which is responsible for accelerating the healing of burn wounds. It accelerates the healing by increasing activity of glycolytic enzyme and providing energy for cell restoration. Aloe vera is one of the easily available safe, cost-effective and potent topical ingredient for burn healing. (11)

Aloe vera can be used to formulated different dosage form for effective speeding up the wound healing process and also increases rate of epithelialization in first and second degree burn(12)

The wound healing properties of aloe vera have been attributed to the high carbohydrate content in its gel. Accman and beta-sitosterol has been highly reported to accerate wound healing. Other constituents include anthraquinones such as aloesin, and emodine as well as phenolic compounds such as querceline, apigenin, myricetin, rutin etc also associated with wound healing acceleration(13)

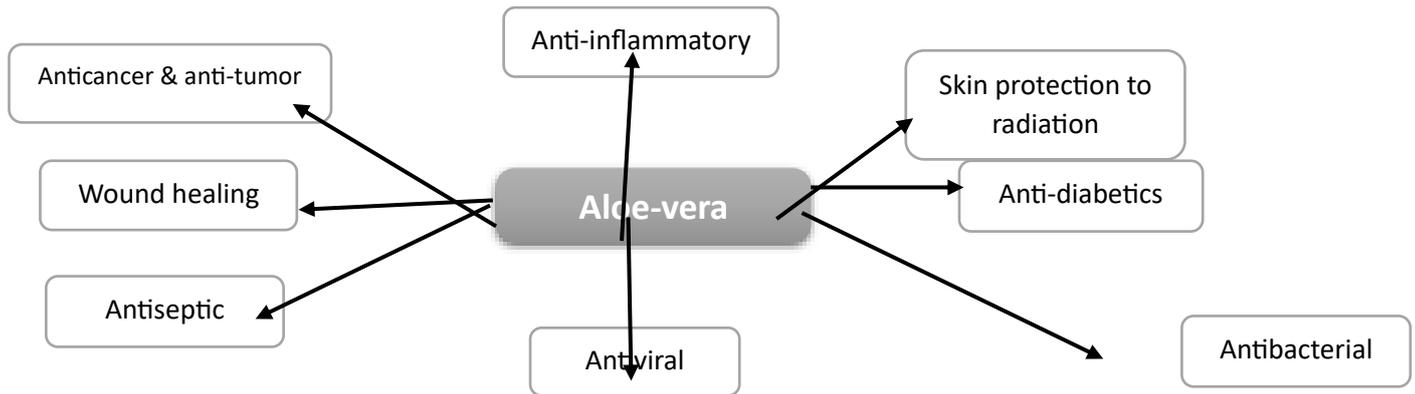
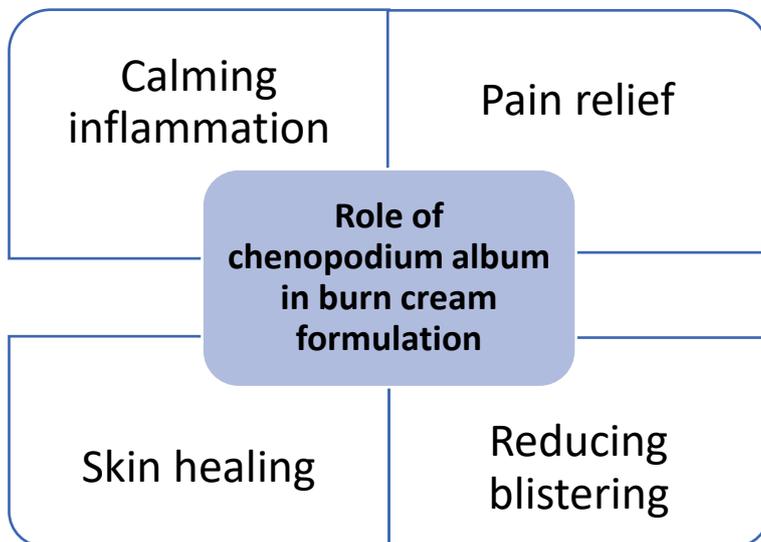


Fig.1. Medicinal properties of aloe vera (6)

➤ **Chenopodium album:**

Chenopodium album Linn. Commonly called as bathu in Hindi and lambs’ quarter in English, belong to Chenopodiaceae family. Chenopodium is used for many beneficial effects such as burns treatment, abdominal pain, intestinal ulcer, piles, diarrhoea and Adema. It has potential activity Asanti-inflammatory, anti-proliferative, anti-septic, antifungal, anti-allergic etc. the wounds healing activity of Chenopodium album is mostly due to its phytoconstituents such as triterpenoids, flavonoids and phenolic compounds which accelerate the wounds healing. (14) Leaves part of Chenopodium album are used for preparation of burn cream which should apply locally.



➤ **Praecitrullus fistulosus:**

Praecitrullus fistulosus (cucurbits) is commonly known as gourds, melon and pumpkin which belongs to Cucurbitaceae family. Many phytochemicals which are present in this plant including tannins, cardiac glycoside, terpenoids, carbohydrate, resins, saponins, carotenoids and phytosterols. Extract of praecitrullus fistulosus (tinda) have been shown to have tannins which is responsible to accelerate the healing property of wound. The plant is rich in phytochemicals which act as free radical scavengers that helps to minimize oxidative stress and cellular damage which is caused by burn. It has natural compounds that help to reduce inflammation associated with burn wound (15).

### 3. Herbal-Based Burn Wound Healing: Mechanisms and Molecular Pathways:

#### 3.1 Chenopodium album:

(a) Anti-inflammatory pathway –

- Burn injury causes inflammation because of cytokines release that are sending out signals to make body react. The burn injury is what triggers these cytokines to start this process of inflammation.
- On applying Chenopodium album extract it cause downregulation of TNF- $\alpha$ , IL-1 $\beta$ , IL-6, inhibition of NF- $\kappa$ B signalling and suppression of COX-2 which results in reduction of edema, pain and tissue necrosis during inflammatory phase.

(b) Antioxidant defense mechanism –

Thermal burn injury produces lots of reactive oxygen species which slow down the healing process of the injury.

- Chenopodium album causes scavenging of free radicals and upregulation of endogenous antioxidants, which protects the fibroblast and keratinocytes from oxidative damage.

(c) Re-epithelialization and tissue remodelling –

Chenopodium album promotes keratinocyte proliferation, regulation of MMP-2 and MMP-9 and balanced collagen remodelling which reduces scarring and restoring normal skin architecture.

#### 3.2 Praecitrullus fistulosus:

This plant contains some phytochemicals such as flavonoid and phenolic compounds which blocks the signal of inflammatory mediators such as NF-KB, which ultimately results in reduction of inflammation and fasten the healing process. Praecitrullus fistulosus extract also make our body to produce TGF- $\beta$  which make skin cells work better and make more collagen which is very important for healing.

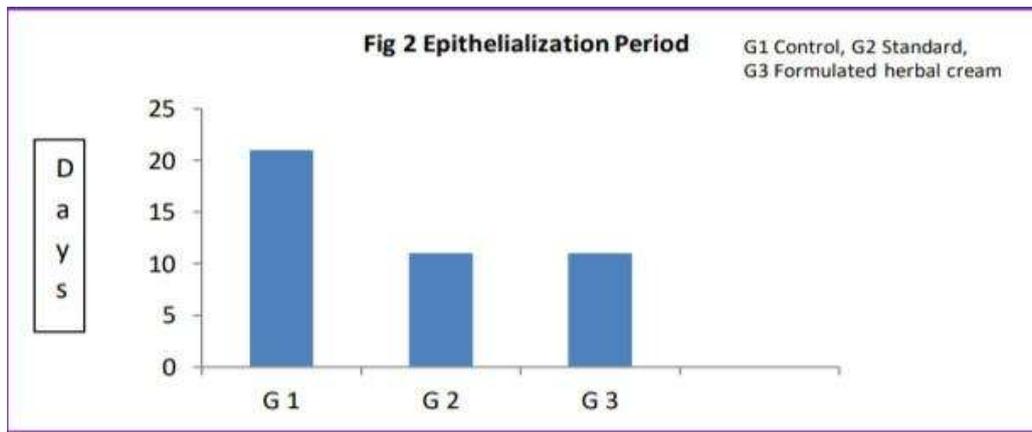
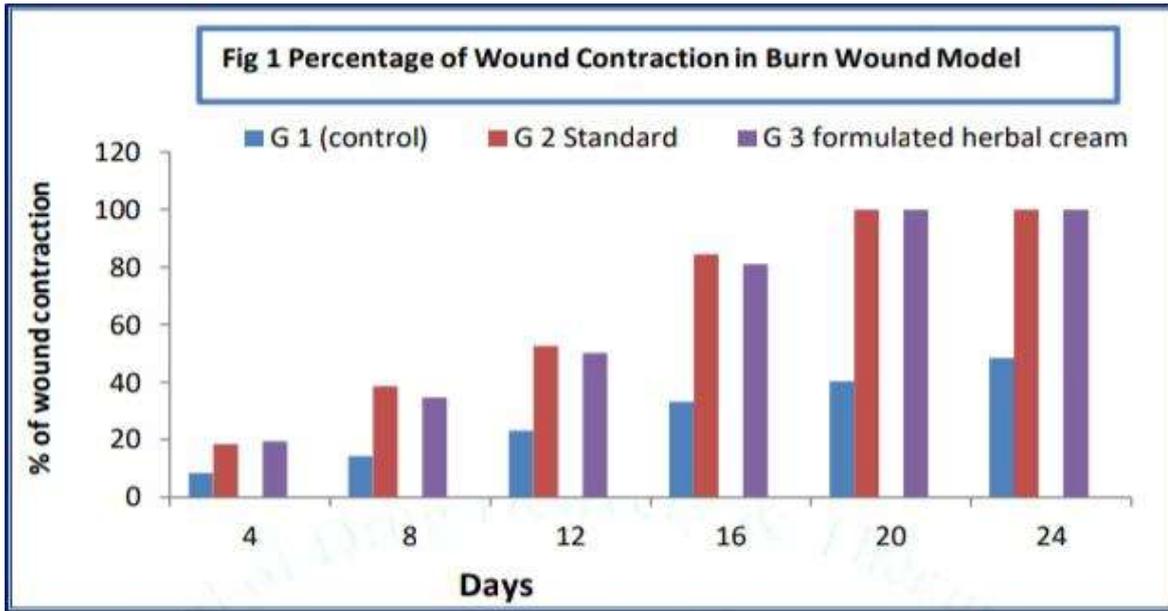
#### 3.3 Aloe-vera:

Aloe-vera extract contain acemannan, anthraquinones, flavonoids and vitamin A, C and E that help in reducing swelling and pain due to burn injury by stopping the release of cyclooxygenase and slow down the NF- $\kappa$ B signalling pathway. Aloe-vera helps in wound healing by stimulating the growth of fibroblasts and the production of collagen. It speedup the process of re-epithelialization by stimulating keratinocyte migration and epidermal growth factor receptor signalling. The antimicrobial and immunomodulatory property of Aloe-vera prevent infection and support tissue repairing, resulting in faster wound healing.

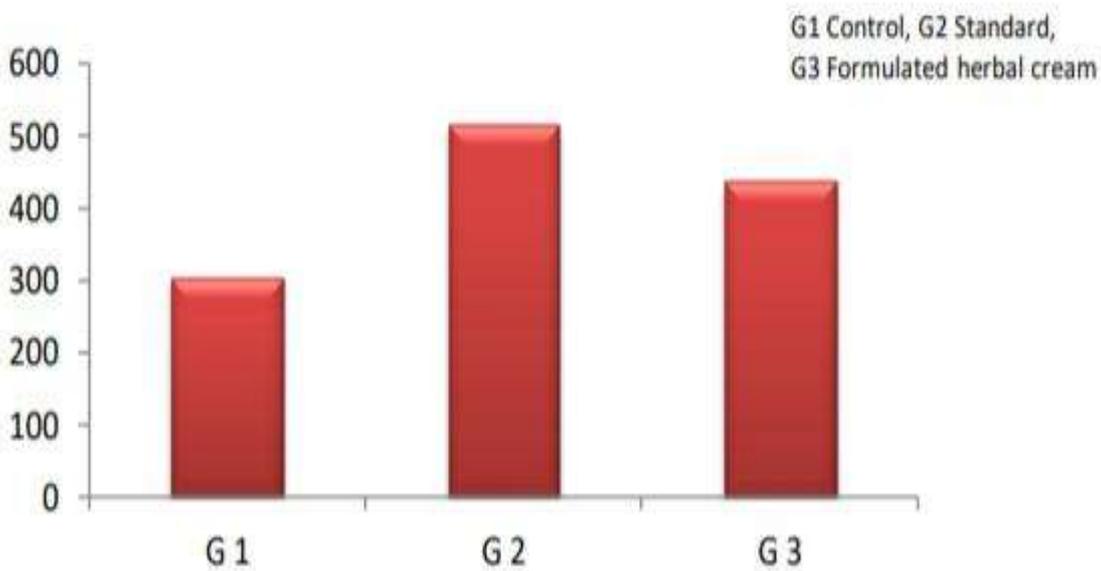
### 4. DISCUSSION:

Based on journal article aloe vera gel contain saponins which have cleansing and antiseptic property, aloecin which accelerate wound healing and anthraquinone which have an analgesic effect (1). Chenopodium album extract is a rich source of alkaloids, phytosterol, tannins, saponin, flavonoids, carbohydrate and glycoside which have greater role in wound healing and tissue regeneration (14). The idea of using natural plants such as aloe vera, Chenopodium album and praecitrullus fistulosus for formulating cream regarding burn management is safe, effective and fewer negative effects than synthetic one.

Other journal article shows the graphical representation on effect of formulated herbal cream on wound contraction, epithelialization period and tensile strength of burn wound (4).



**Fig 3 Effect of formulated herbal cream on tensile strength (g/mm<sup>2</sup>)**



## 5. Future Prospects :

A burn cream which is formulated using herbal ingredients such as *Chenopodium album* (Bathua), *praeitrullus fistulosus* (tinda) and aloe-vera has significant potential for future development because of the following reason-

### 1. High therapeutic efficacy

- Aloe vera has soothing and cooling effect and also form protective barriers that reduces inflammations.
- It has ability to promote epithelial regeneration reduce pain and prevent infections, so that it is a key component for effective burn management.
- *Chenopodium album* possesses significant anti-inflammatory, antimicrobial and antioxidant activities which is beneficial in reducing oxidative stress and microbial contamination in burn wound, so it is valuable for managing minor to moderate burns.
- *Praecitrullus fistulosus*, enriched with vitamine E and natura antioxidants which helps in repairing burn skin, hydration, protection against oxidative damage and also support faster tissue regeneration as well as minimizes scars.

2 Unlike synthetic products, herbal products for burn management is safer alternative with high patient acceptance.

3 The growing trends towards natural, ayurvedic and organic products create more demands towards herbal remedies for personal and pharmaceutical care.

Overall, the combination of these medicine plants has a promising eco-friendly and patient-acceptable approach for burn care with strong potential for commercialization as well as further scientific exploration.

## 6. CONCLUSION:

The main focus of formulating herbal burn cream is safe and effective in burn treatment and show less and no side effects. Demand of herbal remedies increases rapidly in market as it has fewer adverse effects as compare to synthetic one. The plants as discussed aloe vera, *Chenopodium album* and *praeitrullus fistulosus* have potential healing property. So, by combining these powerful herbal ingredients its synergistic effect shows enhanced healing process and cellular regeneration. From the literature studies it can concluded that the extract of this plant has potent wound healing potential.

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