OPEN ACCESS
Scholars International Journal of Traditional and Complementary Medicine
Abbreviated Key Title: Sch Int J Tradit Complement Med
ISSN 2616-8634 (Print) |ISSN 2617-3891 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://scholarsmepub.com/sijtcm/

Review Article

Efficacy of *Kumari* [*Alove Vera* (L)] on *Agnidagdha Vrana* (Burn Wound) With Special Reference to *Ayurvedic* and Modern Aspect: A Review

Dr. Pansare TA[1*], Sole AP[2]

[1]Associate Professor, Government Ayurved College, Osmanabad, Maharashtra, India
[2]Assistant Professor, Sole A.P., Ashtang Ayurved College, Pune, Maharashtra, India

DOI: 10.36348/sijtcm.2020.v03i01.001 | **Received:** 20.12.2019 | **Accepted:** 27.12.2019 | **Published:** 14.01.2020

***Corresponding author:** Dr. Pansare TA

Abstract

Nature has gifted numerous plants to mankind for prevention and management of diseases. *Kumari* [*ALOVE VERA* (L.)] belonging to Family Liliaceae is traditionally advocated by the IndianAyurvedic medicine to treat a huge variety of health problems. Its burn wound (Agnidagdha vrana) healing action has been mentioned in Ayurvedic classics viz. Kaiyadev Nighantu, Bhavprakash Nighantu and Shaligram Nighantu. According to Ayurveda, due to its Dahaprashman (cooling), *Rasayana* (rejuvenating), Vishaghna (anti-toxic), Balya (strength providing) actions and Kledashodhan (removes kleda) acions, it helps in burn wound healing. This plant contains Lupeol, salicylic acid, Anthraquinones, Glycoproteins, Polysaccharides etc. which are accountable for speedy wound healing. It is endowed with varied pharmacologicalactivities like antiseptic, anti-inflammatory, immune-modulatory, analgesic, anti-bacterial, moisturizing and cooling and anti-oxidant that aid wound healing.This plant has potential to cure sunburns, burns and minor cuts, and even skin cancer. The present review compiles information on Ayurvedic aspect as well as phytoconstituents and relevant pharmacological studies of Kumari regarding burn wound (Agnidagdha vrana) healing action. The present data is an endeavour to give scientific justification to the acclaimed activity i.e. its burn wound healing potential (Agnidagdhavranapaha) as stated in Ayurveda. It provides encouragement to investigators for conducting further research in order to develop an efficient and safe innovative chemical entity for the cure of burn wound.

Keywords: Kumari, *Aloe vera*, *agnidagdhavrana*, burn wound.

INTRODUCTION

Skin burn is a global problem that may result in ugly scarring and serious handicapping. Numerous studies confirmed that burn infection is the major cause of mortality in patients with extensive burns, therefore many researchers attempted to achieve accurate treatment methods to reduce the threat of wound infections and to curtail the period of treatment of patients with burn wounds [1]. Healing of burn is still a challenge in modern medicine and there are only a few drugs capable of speed up wound healing and as alternative plants were rich sources to survey [2-6].

The use of medicinal plant either as a single drug or in combination is growing in the health care of human being. Medicinal plants can be vital source of previously unidentified chemical substances with potential therapeutic effect. The field of herbal medicine is getting popularized both in developed and developing countries in the last few decades since theherbal medicines are economical and have natural origin with higher safety limits with lesser or no side effects.

Kumari [*Aloe vera* (L.) Burm. *f.* in synonym *A. barbadensis* Miller] belonging to the family Liliaceae is one of the most important medicinal plants which is often called as 'miracle plant', the 'nature healer' or 'Plant of immortality'. It has an ancient history in medicine and is recognized as 'burn tree" or 'first aid plant'[7]. Ancient physicians regarded it as a blessing to mankind. It has produced the enormous traditional role inendemic system of rules of medicine such as the Siddha, Unani, Ayurveda and Homeopathy [8].The plant looks like a cactus with green, its shape like sharp knife, leaves that are flesh, narrowing, spinous, emarginated and filled up from a clear white viscous gummy gel [9]. This is a hardy, perennial, tropical, drought-resistant and succulent plant. It grows mainly in the dry region of Africa, Asia, Europe and America. In India it is found in Rajasthan, Andhra Pradesh, Gujarat, Maharashtra and Tamil Nadu.

In cosmetic the external use of aloe primarily acts as skin healer and prevents injury of epithelial tissues, cures acne and gives a youthful glow to skin. In Ancient *Ayurvedic* literature the plant Kumari is documented to possess several valuable and multi-dimensional therapeutic effects. It is a renowned Rasayana (Rejuvenating) herb which delays aging and imparts longevity, immunity and body resistance against several diseases. It is frequently used in the management of a variety of diseases such as indigestion, liver and spleen disorders, jaundice, skin disorders, wound etc. Its various formulations are prescribed as an appetite-stimulant, purgative, emmenogogue and antheimintic etc. Its efficacy in burn healing (Agnidagdhavranapaha) is stated in Ayurvedic classics viz. Kaiyadev Nighantu, Bhavprakash Nighantu and Shaligram Nighantu. It has been used for the treatment of wounds and burns for centuries [10].

The plant produces at least six antiseptic agents like lupeol, salicylic acid, urea nitrogen, cinnamonic acid, phenols and sulphur. All of these substances are known as antiseptics as they kill or control mould, bacteria, fungus and viruses, elucidating why plant has the capability to get rid of many internal and external infections. The two very effective pain-killer i.e. Lupeol and salicylic acid are present inthe juice of Aloe. Aloe contains at least three anti-inflammatory fatty acids viz. cholesterol, campesterol and β-sitosterol which are highly effective in treatment of burns, cuts, scrapes, abrasions, allergic reactions. The Aloe vera leaf possesses more than 75 food nutrients, 200 chemical active compounds including 20 minerals, 18 amino acid & 12vitamins, controls then ageing process of skin. A more recent review concludes that the cumulative evidence supports the use of *Aloe vera* for the healing of first to second degree burns [11].

This review highlights the information particularly about burn wound healing action of Kumari i.e. Aloe vera according to Ayurvedic aspect as well as it emphasizes Phytochemical constituents and various pharmacological properties of this popular and promising herb which may provide support to researchers for conducting advance research in order to develop an efficient and safe novel chemical entity responsible for its claimed traditional use i.e. its burn wound healing potential (Agnidagdhavranapaha) stated in Ayurveda.

Classical text books of Ayurveda and Nighantus were reviewed for documenting the information about Kumari.The published works on various scientific journals and web pages were consulted to review for available information about Kumari in terms of phyto-pharmacological information regarding burn healing.

Agnidagdhavran and Ayurveda

Classical textbooks of Ayurveda contain vivid descriptions of burn injury and its management. Management of burn wound depends upon the depth of the injury in conjunction with other factors common for all types of wounds. Bedside clinical evaluation plays an important role as the most widespread and cost-effective method for depth diagnosis [12].

Depth of burn wound

In Susruta Samhita Clinical features of all the types have been stated in terms of appearance, presence/absence of blisters, presence/absence and nature of pain, suppuration, extent of tissue destruction, time and nature of healing, systemic involvement etc. which specifies the depth of damage on account of thermal injury [13].

Plusta: Discoloration; Burning pain without any blisters.

Durdagdha: Blisters, severe pain, redness, suppuration, pain lasting for long interval.

Samyagdagdha: Without the features of *Atidagdha*, colour of wound like ripe palm tree fruit, neither elevated nor depressed, along with the features as mentioned above.

Atidagdha: Sloughing out, injuries of vessels, ligaments, joints and bones; fever; burning sensation; thirst; fainting; the wound heals very gradually; discoloration after healing.

The plentyof medicines have been revealed in Ayurvedic classics for burn wound care. These medicines had been used in ancient times and pre-antibiotic age most possibly with success. So there is a requirement of revalidating these preparations in terms of modern parameters and thus making them suitable and accessible for the mankind.

Ayurvedic Aspect of Kumari

The name Kumari means that the plant wishes to give the nutritious health and strength by its Rasayana (Rejuvenating) property.

The various properties of Kumari are revealed in Nighantus like Madanpal, Shodhal, Kaiyedev, Raj, Bhavprakash, Nighantu Ratnakar, Shaligram and Priya Nighantu and Nighantu Aadarsha.

The synonyms like Ambudhisrava, Vipulsrava (filled with a clear viscous gel), Atipicchila (very slimy), Mridu (soft leaves), etc. explain external morphology of the plant while some synonyms such as Ajara, Taruni, (anti-aging), Amara, Veera, Rasayani (rejuvenating), Vranghni (wound healing) etc.elucidate the pharmacological properties of Kumari. Its burn wound (Agnidagdha vrana) healing action has been

mentioned in Ayurvedic Nighatus (lexicons) viz. Kaiyadev Nighantu, Bhavprakash Nighantu and Shaligram Nighantu.

Rasapanchak of Kumari

Rasa: Tikta, Madhur
Veerya: Sheet
Vipak: Katu
Guna: Picchila, Sara, Guru, Snigdha
Prabhav: Bhedan

Action on Doshas

It alleviates Vata by rather MadhurRasa; Picchila, Guru and Snigdha Guna. It alleviates Pitta by Tikta, Madhur Rasa; Sheeta Veerya and Sara Guna. It alleviates Kapha by Tikta Rasa and Katu Vipak.

Thus it is Tridoshashamak plant. Its various pharmacological actions are viz. balya (provides strength), bhedan (breaks and removes mala- unwanted substances), brihan (nutritive), Rasayan (Rejuvenating), Vishaghna (removes toxins), and Aghidagdha vranaghna (burn healing).

In Ayurvedic classics, various therapeutic uses of Kumari regarding wound healing are stated. The reference that local application of juice of Kumari and cumin seeds powder definitelylessens the burning sensation occurs in Rasaratnasamucchaya.

Burn Healing and Modern science

The usual response of an organism to injury or wound is either regeneration (the complete restoration of the damaged part) or repair (the reconstruction of the injured region). The scar tissue is properly covered, by an epithelium at the site of injury. When skin is injured or wounded the dermis responds primarily to repair while the epidermis responds to regeneration; the collective response of the skin to injury is called as wound healing. Mechanisms involved in wound healing are epithelialisation, contraction, connective tissue (matrix) deposition. Epithelialisation is a process where keratinocytes migrate from the lower skin layers and divide. Contraction process involves wound contraction and narrowing or closing of the wound. In connective tissue and matrix deposition fibroblasts come into the area and produce new matrix and collagen is laid down over and amongst this amorphous material. After it the epithelial tissues may migrate over this. The matrix consists of collagen, elastin, fibronectin, laminin, hyaluronic acid, and proteoglycans. These structures and chemicals provide strength and support, allow expansion and contraction, provide a surface for cell movement, and facilitate necessary chemical reactions to occur. Wound healing generally needs support at three stages. First, improving general resistance and support mechanisms that could be achieved from rejuvenative, adaptogenic, palliative, antioxidant, and cleansing, detoxifying, buffering and lubricous activities. Second, stimulating the repair and regenerative mechanisms to extend cell life, cell migration and cell binding, remove skin blemishes, and improve tensile strength or elasticity of the skin, improved moisture holding capacity of skin. Third, therapeutic and nutritional activities including anti-inflammatory, antiseptic and antimicrobial, protein and collagen synthesis and enhanced stability of biomembranes.

Antioxidants can interfere with the oxidation process by reacting with free radicals, chelating catalytic metals and also by acting as oxygen scavengers. Free radicals and other reactive oxygen species (ROS) are considered to be important contributory factors in the aging process. Oxidative stress also plays significant role in impair wound healing. Botanicals with anti-oxidant or free radical scavenging activity thus can play a significant role in healing of wounds [14].

Burn healing can be regarded as a particular kind of wound healing and most of the skin reactions are the similar. The conditions for burn healing differ according to the depth of the burn wound in addition to several factors can interfere with the healing process. Consequently three zones have been known in a burn, an inner zone (coagulation zone) where cell damage is irreversible, a middle zone (statis zone) where damage is severe and an outer zone (hyperemic zone) where recovery is likely [15].

Moreover there are three degrees of burns, the first in which the epidermis only is damaged, the second where some dermal damage also occurs but where epithelial regeneration is possible and the third where both epidermis and dermis are irreversibly damaged.

1st and 2nd degree burns are known together as partial thickness burns. 2nd degree burns is the deeper injury than 1st degree burn. It involves all the epidermis and much of the corium. The deep dermal burn is of important clinical importance.

Most 2nd degree burns are characterized by blisters. They are usually accompanied by considerable subcutaneous oedema. The rate of healing is dependent upon the depth of skin destruction on whether or not presence of infection. In superficial partial thickness burns, healing usually takes place uneventfully in a period of 10 to 14 days unless infection supervenes.

Deep dermal burns are injuries that extend down deep in the cornium lining of the sweat glands and their follicles. If the wound is appropriately protected it will be covered with a thin layer of epithelium in 25 to 35 days. There may be thick scarring.

It is now general knowledge that the deep burns heal with hypertrophic scars. The healing dermis microscopically presents with omnipresent myofibroblasts. These fibroblasts like cells attach to the adjacent collagen fibres. It has been assumed that the microfibroblasts are responsible for the burn scar contracture and collagen disorientation characteristic of hypertrophic burn scar.

Modern classification of burn depth on clinical appearance is as follows

Typical clinical appearance of burn depth:

- First degree: Involves only the epidermis and never blisters. It appears like 'sunburn' and is not included in the %TBSA calculation.
- Second degree superficial: Pink, homogeneous, normal capillary refill, painful, moist, intact hair follicles
- Second degree deep: Mottled or white, delayed or absent capillary refill, dry, reduced sensation or insensate, non-intact hair follicles
- Third degree: Dry, white or charred, leathery, insensate.

Modern aspect of *Aloe vera*

Phyto-chemical constituents of *Aloe vera*

The Aloe vera plant has flavonoids, terpenoids, lectins, unsaturated fats, cholesterol, anthraquinones,chromones mono and polysaccharides ,tannins, sterols, salicylic corrosive, destructive regular acids, proteins,saponins, vitamins, minerals, aloin, anthrone, aloe emodin, aloetinic corrosive, choline and salicylate, complexmucopolysaccharides like hyaluronic corrosive, sapogenins and chemical, for example, catalase, celluase and alliinase[16].

The outermost layer of leaf of Kumari consists of 15-20 cells thick protective layer producing carbohydrates and proteins [17]. The active components of aloe comprise anthraquinones, chromones, poly-saccharides, and enzymes. The anthraquinones and chromones are accountable for the anti-cancer activity, anti- inflammatory, and evacuating [18]. The elements Al, Ba, Ca, Fe, Mg, Na, P, Si etc has also been reported to be present in *Aloe vera* gel [18-20].

The bitter yellow latex of pericyclic tubules in the outer layer of the leaves possess derivatives of hydroxyanthracene, anthraquinone and glycosides aloin A and B from 15% - 40% in different investigations [21-23]. The other active principles of *Aloe* contain hydroxyanthrone, aloe- emodin-anthrone 10-C-glucoside and chrones.

The bitter yellow latex containing anthraquinones and glycosides has been reported from the middle layers of leaf [17]. The parenchymatous tissue or pulp shown to have proteins, lipids, amino acids, vitamins, enzymes, inorganic compounds and small organic compounds in addition to the different carbohydrates. There is some evidence of chemotaxonomic variation in the polysaccharide composition [24-26]16-different polysaccharides and 12 major polypeptides (mol wt 15 - 77 kD), and various glycoproteins (29 kD in leaf gel).

The innermost layer of leaf gel has water up to 99%, with glucomannans, amino acids, lipids, sterols and vitamins [17, 26]. The other potentially active ingredients consist of vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids, and amino acids [27-30]. It has numerous monosaccharide's and polysaccharides; vitamins B1, B2, B6, and C; niacinamide and choline, several inorganic ingredients, enzymes (acid and alkaline phosphatase, amylase, lactate dehydrogenase, lipase) and organic compounds (aloin, barbaloin, and emodin) [31].

The main functional component of *Aloe vera* is a long chain of acetylated mannose [20, 32, 33]. Aloe gel is frequently commercialized as powdered concentrate. The therapeutically, it is used to prevent progressive dermal ischemia due to burns, frostbite, electrical injury and intra arterial drug abuse. *In vivo* analysis of these injuries demonstrates that this gel acts as an inhibitor of thromboxane A2, a mediator of progressive tissue damage [29].

About 23 polypeptides are present in Aloe juice which helps to control a broad spectrum of immune system diseases and disorders.

The sterile property of Aloe vera is a consequence of proximity of six clean experts particularly lupeol, salicylic destructive, urea nitrogen, cinnamonic destructive, phenols and sulfur. These blends have inhibitory action on parasites, organisms and diseases. Despite the way that an extensive part of these usages are fascinating, controlled trials are critical to choose its practicality in all diseases [34].

The Anti-inflammatory activity of aloe vera gel has been exposed by various in vitro and in vivo contemplates bradykinase movements of body. The peptidase bradykinase was isolated from aloe and shown to break down the bradykinin, an inflammatory substance that induces pain [35].

Wound improving Property of Aloe vera gel has been credited to Mannose-6-phasphate actually, glucomannan and plant development harmone gibberellins connects with development variable receptor of fibrobroblast and invigorate its action and proliferation for expansion collagen blend its topical and oral organization of aloe as indicated by Hayes [36].

Favonoids and phytosterols of Aloe vera promote Epithelialisation for wound healing process

with increased capillary formation & fibroblast proliferation enhancing the rate of epithelisation.

Research work done on Burn healing activity of Aloe

- Aloe vera is best recognized for its soothing and healing effects on burn and other wounds. Even if burn wound healing was one of the chief indications for use of *Aloe vera* gel in several animal and clinical studies, there are few studies comparing the efficacy of this gel and SSD in the treatment of burns in animals [37, 38]. Silver sulfadiazine is regularly used to control the microbiologic flora within burn wounds; however, silver sulfadiazine has been known to slow down healing in some instances because of its cytotoxicity towards human keratinocytes and fibroblasts [39]. When silver sulfadiazine was used with aloe preparations, these effects were reversed [38].
- Aloe vera gel extracts were compared with silver sulfadiazine, salicylic acid cream and plain gauze occlusive dressing. It was observed that Aloe vera gel extracts permit quicker healing of burn wounds [37]. Aloe vera could expose the actions of both anti-inflammation and wound healing promotion when applied on a second degree burn wound [40]. Aloe vera treatment of wounds in diabetic rats may improve the process of wound healing by influencing phases like inflammation, fibroplasia, collagen synthesis and maturation and wound contraction. These effects may be because of the reported hypoglycemic effects of the aloe gel [41].
- A review of four clinical trials evaluating the effect of Aloe vera on burn wounds demonstrated that aloe vera significantly shortened the wound healing time (by approximately eight days) compared to control. They reported that it may be an efficient treatment for first and second degree burns[42].
- *Aloe Vera* was studied for burn wounds by routine dressing by *A. Vera* extract every 3rd day in chemically produced burn on healing subjects. The wound healing time in addition to bacteriological control was significantly in Aloe group [43].
- Another study illustrated that an aloe cream reduced the healing time in patients with burn injuries compared to silver cream. It might have better efficacy over silver sulfadiazine cream for treating second-degree burns [44].
- The aloe vera gel extract permitted faster healing of burns, and re-established the vascularityof burn tissue of a guinea pig [37, 45].
- In an animal experiment, sixteen rats were randomly assigned to one of two groups, each group of 8 rats. A deep second-degree burn on the lower back and 3rd degree burn on upper back of each rat were created. Burns were dressed daily with aloe vera extract in group 2 and silver sulfadiazine in group 1. Response to treatment was assessed by digital photography during treatment until day 32. Histological parameters (PMN, epithelialisation, fibrosis and angiogenesis) were assessed after biopsy of scar at the end of research. The study explained that wound healing was more visible in aloe vera group. Moreover the speed of healing in aloe vera group was better than silver sulfadiazine group [46].
- Hotplate burns to guinea pig skin healed more speedily after topical aloe gel application and interestingly, the bacterial count was reduced by 60% (81, 109). An another study revealed healing activity towards gamma-radiation burns; but only if applied quickly, when it produced more quick healing than controls but only as peak reaction levels were reduced. Here it was wonder that aloe gel affected the induction of the skin reaction but not the later healing phases. In a similar trial conducted on mice, differences were observed in the effect on first, second and third degree burns. Gel preparations delayed the inflammatory response and accelerated the recovery time for first and second degree burns and epithelialisation was rapid. Third degree burns proved more stubborn. A synergism was noted between the gel and the cream base used. Elsewhere, partial thickness burns were observed to heal more quickly when treated with aloe gel, compared with vaseline, both growth of epithelial cells and organization of fibro-vascular and collagen tissue being stimulated [47].
- The Aloe gel has been used for the management of radiation burns and radiation ulcers [48], and complete healing has been seen in two radiation burns patients [49]. The fresh gel was more efficient than the cream [49, 50] as Aloe gel-treated lesions healed quicker (11.8 days) com-pared to burns treated with petroleum jelly gauze (18.2 days) by *Fulton* [51]. The 27 patients with partial thickness burns have been treated with Aloe gel in a placebo-controlled study [52].
- A review illustrated that the cumulative evidence supported the use of *Aloe vera* for the healing of first to second degree burns [53].
- In a study of twenty-seven patients with partial thickness bum wound, they were treated with aloe vera gel compared with vaseline gauze. It revealed the aloe vera gel treated lesion healedfaster than the Vaseline gauze area. The average time of healing in the aloe gel area was 11.89days and 18.19 days for the Vaseline gauze treated wound. Statistical analysis by using t-test andthe value of $P<0.002$ was statistically significant. In histologic study, it showed early epithelialisation in the treated aloe vera gel area. Only some minor adverse effects, such as discomfort andpain were encountered in the 27 cases. This study showed the effectiveness of aloe vera gelon a partial thickness bum wound, and it might be beneficial to do further trials on bum wounds [54].
- This study showed the clinical usefulness of aloe vera gel for the treatment of partial thickness burn

wounds. From the histopatological point of view, aloe vera gel can stimulate rapid growth of squamous epithelium and organize reformed dermal fibro-vascular and collagen tissue. Moreover, less inflammatory cell infiltration might indicate the antiseptic property of aloe vera gel as has been previously recognized. These findings support previous investigations. These findings were not seen in the Vaseline gauze treated area. Adverse effects, such as transient discomfort or pain were considered less significant. No allergic reaction or dermatitis was found during the study in contrast to the findings of some investigators. Evidence of beneficial effect associated with the use of aloe gelwas sufficient to warrant implementation of further trials on burn wounds [54].

DISCUSSION

Healing of burn wounds remains a challenge to modern medicine, although many antiseptics have been discovered. Burn management necessitates significant length of hospital stay, high-priced medication, several operative procedures and long-lasting period of rehabilitation. This makes burn care an expensive system and attempt should be made to offer a shorter inpatient care for burn patients.First degree and second degree superficial can be correlated with *Plusta while* Second degree Deep and third degree wound can be correlated with *Samyagdagdhaand and Atidagdha respectively*.

Kumari has potential to cure sunburns, burns and minor cuts, and even skin cancer. Owing toits therapeutic properties like wound and burn healing, *Aloe* is now used in a variety of commercially available topical medications for wound healing and skin care.The clear gel of Aloe has anoutstanding ability to heal wounds, ulcers and burns by forming a protective coating on the affected areas and accelerating the healing process.

The activities of Aloe vera like antiseptic [55], anti-inflammatory [56-58] immune-modulatory [59-61], analgesic [62], anti-bacterial [63], moisturizing and cooling [64] and anti-oxidant [65] aid wound healing.

Mechanism of *Kumari* in Agnidagdha wound healing

Kaiyadev Nighantu, *Bhavprakash Nighantu* and *Shaligram Nighantu* have illustrated efficacy of Kumari in burn wound i.e. *Agnidagdhavranapaha*. According to *Ayurveda* the action of drugs is interpreted on the basis of *Rasapanchaka* that exhibits the drug action.

Rasa: *Tikta (bitter) rasa* absorbs the fluid and slimy material from wound by reason of *Vayu Mahabhoota predominance* and enhances wound healing. It vacates space on account of*Aakash Mahabhoota* and passes through even to miniature channels due to *Sookshma Guna*, thus helps the drug to reach at cellular level and remove toxins after bhedan karma of Kumari.

Madhur Rasa helps to boost the Dhatubala (strength of tissues), and ojas i.e. essence of Dhatus.The Rasayana (rejuvenating) property of Kumari helps to regenerate new tissues and supports the nourishment of *Dhatus at* the region of wound and accelerates wound healing.

Veerya: Sheet veerya helps to reduce burning sensation and provides soothing and cooling effect.

Vipaka: Katu vipaka pacifies vitiated *Kapha and pooya (pus).*

Guna: Kumari performs Sandhaniya (wound healing) activity due to Snigdha and Picchila gunas heals chronic wounds by vranaropan action. Sara guna helps to remove the mala and kleda from burn wound.

In agnidagdha vrana, pain and redness occurs due to vitiated Vata and Pitta. Kumari alleviates vata and pitta. Hence reduces pain and redness of the wound. Due to its explicit Rasapanchaka, Kumari performs burn wound healing action.

Mechanism of Aloe verain burn wound healing

Wound healing is a dynamic process which takes place in 3 phases. The first phase is inflammation, hyperaemia and leukocyte infiltration. The second phase includes removal of dead tissue. The third phase of proliferation comprises epithelial regeneration and formation of fibrous tissue [66].

A more recent review demonstrates that the increasing evidence supports the use of *Aloe vera* for the healing of first to second degree burns [67].

Burn patients are more predisposed for infection due to suppressed immunity. Burn wound is a fertile land for the growth of various microorganisms.The plant leaves have numerous vitamins, minerals, enzymes, amino acids, natural sugars and other bioactive compounds with emollient, purgative, antimicrobial, anti inflammatory, anti-oxidant, antifungal, antiseptic and cosmetic values for health care.

Healing of burn wound is really dependent on the angiogenesis which is the mainstay in the granulation tissue formation [68].

The glycoprotein promotes cell proliferation, as a resultaloe improves wound healing by enhancing blood supply and increased oxygenation [69, 70]. Growth of new blood capillaries (angiogenesis) and tissue regeneration in the burn tissue for a guinea pig has been reported, however, no specific constituents

were identified [71]. Moreover, a low molecular weight compound from freeze-dried gel stimulated angiogenesis in chick chorioallantoic membrane, and a methanol-soluble fraction of the gel stimulated proliferation of arteries in endothelial cells and induced them to invade a collage substrate [72]. Extracts of *Aloe vera*[73], showed promotion of angiogenisis around wound site.

Aloe cream is imperative in wound healing in burn animals. The antimicrobial, cell proliferation and inflammatory effects may be the mechanism of aloe action in burn healing.

In full-thickness skin burn, aloe illustrates beneficial effect by lessening the inflammation significantly and providing a more mature granulation tissue which could speed up healing and might produce a sound well-remodelled scar.

The anti-inflammatory effects of aloe can contribute to resolving the inflammatory process induced by burn injury [74].

Wound healing was observed by creating burn wound following a well-established method [75]. It was reported that aloe possesses potential burn and wound healing activity and emodin played the major role in mediating these activities.

Thus in burns and leg ulcers Aloe vera appears to speed up the healing of damaged epithelial tissue by providing essential micronutrients, anti-inflammatory effect, antimicrobial effect and stimulation of skin fibroblasts [76].

The wound healing property of *Aloe vera* gel has been attributed to Man-nose-6-phosphate [77]. In fact, glucomannan and plant growth harmone gibberellins interacts with growth factor receptors of fibrobroblast and stimulate its activity and proliferation that increases collagen synthesis in topical and oral administration of Aloe according to Hayes [78]. It too increases synthesis of hyaluronic acid and derma-tan sulfate in the granulation tissue of a healing wound [79]. Acemannan is regarded as the chief functional component of *Aloe vera* and is composed of a long chain of acetylated mannose [80-82]. This complex carbohydrate increases speed of wound healing and decreases radiation induced skin reactions [83, 84]. Macrophage-activating potential acemannan may stimulate the release of fibrogenic cytokines [84, 85]. Direct binding of acemannan to growth factors and their stabilization may result in promotion of prolong stimulation of granulation tissue [83].

The *Aloe vera* gel play chief role in stimulation of the complement linked to polysaccharides, hydration, insulation, and protection. Application of fresh gel to normal human cells *in vitro* promoted cell growth and attachment. The wound healing potential was due to a high molecular weighted polypeptide in healing of rat's excision wounds [86].

The probable mechanism are providing necessarymaterial for healing, enhancing blood flow to burn area, decreased inflammatory response, and reduced rate of infection. It accelerates the flow of blood towards the wounded area. It is the best wound dressing ever discovered [87]. In 1998 Chitra *et al.* showed that Aloe not only accelerates healing but also prevents injured surface from getting infected [88].

Thus Whole-leaf fresh juice (aloin or barbaloin, tannins, resins, polysaccharides) or mucilaginous gel (glucomannan, acemannan, sterols, glycoproteins) decreases the risk of infection and accelerates wound healing by stimulating fibroblast proliferation, deposition of collagen, angiogenesis and production of growth factors. All these valuable effects were revealed by several experimental in vitro (NCTC2544 human keratinocytes) [89] or in vivo models (mice, Wistar or Sprague–Dawley rats, Hartley guinea pigs, rabbits, domestic pigs) of full-thickness skin cuts, burns and frostbites [90, 91], and by randomized clinical trials, made on hundreds of volunteers [92, 93].

Thus the study provides a scientific rationale for the traditional use of these plants in the management of burn wounds.

CONCLUSION

Kumari helps in Agnidagdha vrana healing by Dahaprashman (cooling), Rasayana (rejuvenating), Vishaghna (anti-toxic), Balya (strength providing) and Kledashoshan (absorbing kleda), actions. Tikta rasa and bhedan action of Kumari helps to remove kleda from wound while its sheet veerya reduces burning sensation. Madhur rasa and rasayana action of Kumari facilitaterevival of new tissues and sustain the nourishment of Dhatus at wounded areahence hastensburn wound healing. The cumulative evidence tends to support that aloe vera might be anefficient interventions used in burn wound healing for first to second degree burns. In burn wound, the probable mechanism of Aloe are providing essential material for healing, increasing blood flow to burn area, promoting healthy granulation tissue, increasing the rate of epithelialisation, decreased inflammatoryresponse, and declining rate of infection by its phyto-constituents like lupeol, salicylic acid, anthraquinones, glycoproteins, polysaccharides, flavanoids, phytosterol etc. It accelerates burn wound healing by stimulating fibroblast proliferation, deposition of collagen, angiogenesis and production of growth factors. The activities of Aloe vera like antiseptic, anti-inflammatory, immune-modulatory, analgesic, anti-bacterial, moisturizing and cooling and anti-oxidant aid burn wound healing. The above gathered data gives explanation about therapeutic efficacy of Kumari

regarding burn wound healing action which has been ascertained by several research scholars using the modern pharmacological experimental models. Thus the study validates that the significance of the plant Kumari has been recognized and documented since ancient time owing to high merit of its variety of chemical compounds, which hold significant medicinal properties that are able to heal burn wounds. Hence, it offers a scope for advance research and more well-designed clinical trials to investigate the therapeutic applications of this inexpensiveand marvel drug with less adverse effects and properties like reduced period of healing and decreased rate of hypertrophic scar for the welfare of burn wound patients.

REFERENCES

1. Manafi, A., Kohanteb, J., Mehrabani, D., Japoni, A., Amini, M., Naghmachi, M., & Khalili, N. (2009). Active immunization using exotoxin A confers protection against Pseudomonas aeruginosa infection in a mouse burn model. *BMC microbiology*, *9*(1), 23.
2. Hazrati, M., Mehrabani, D., Japoni, A., Montasery, H., Azarpira, N., Hamidian-Shirazi, A. R., & Tanideh, N. (2010). Effect of honey on healing of Pseudomonas aeruginosa infected burn wounds in rat. *Journal of Applied Animal Research*, *37*(2), 161-165.
3. Amini, M., Kherad, M., Mehrabani, D., Azarpira, N., Panjehshahin, M. R., & Tanideh, N. (2010). Effect of Plantago major on burn wound healing in rat. *Journal of Applied Animal Research*, *37*(1), 53-56.
4. Hosseini, S.V., Niknahad, H., Fakhar, N., Rezaianzadeh, A., Mehrabani, D. (2011). The healing effect of honey, putty, vitriol and olive oil in *Psudomonasareoginosa*infected burns in experiental rat model. *Asian J Anim Vet Adv*. 6:572-579.
5. Hosseini, S. V., Tanideh, N., Kohanteb, J., Ghodrati, Z., Mehrabani, D., & Yarmohammadi, H. (2007). Comparison between Alpha and silver sulfadiazine ointments in treatment of Pseudomonas infections in 3rd degree burns. *International Journal of Surgery*, *5*(1), 23-26.
6. Kahkeshani, N., Farahanikia, B., Mahdaviani, P., Abdolghaffari, A., Hassanzadeh, G., Abdollahi, M., & Khanavi, M. (2013). Antioxidant and burn healing potential of Galium odoratum extracts. *Research in pharmaceutical sciences*, *8*(3), 197.
7. Ghasemi, N., & Dehkordi, N. (2002). Iranian herbal pharmacopeia. *Herbal Pharmacopoeia Committee. Tehran: Ministry of Health and Medical Education, Department of Food and Drug Administration*, 121-78.
8. Yongchaiyudha, S., Rungpitarangsi, V., Bunyapraphatsara, N., & Chokechaijaroenporn, O. (1996). Antidiabetic activity of Aloe vera L. juice. I. Clinical trial in new cases of diabetes mellitus. *Phytomedicine*, *3*(3), 241-243.
9. Himes, S., Sharma, S., Mishra, K., Singhai, A.K., & Chaubey, N. (2011). Qualitative & Quantitative profile of aloin isolated from Aloe era. International Research Journal of Pharmacy, *2*(9): 121-122.
10. Bedi, M.K., Shenefelt, P.D.(2002). Herbal therapy in dermatology. Arch Dermatol, 1138: 232-42.
11. Maenthaisong, R., Chaiyakunapruk, N., Niruntraporn, S., & Kongkaew, C. (2007). The efficacy of aloe vera used for burn wound healing: a systematic review. *burns*, *33*(6), 713-718.
12. Devgan, L., Bhat, S., Aylward, S., & Spence, R. J. (2006). Modalities for the assessment of burn wound depth. *Journal of burns and wounds*, *5*.
13. Acharya, S. D., Acharya, V. J. T., & Kavyatirtha, N. R. A. (2014). Nibandha Sangraha commentary on Sushruta Samhita: Sutra sthana 46/360, Anna-pana Vidhi Adhyaya. *Varanasi: Chaukhamba Sanskrit Sansthan*, 240.
14. Gutteridgde, J.M.C.(1995). Free radicals in disease processes: a complication of cause and consequence. Free Radic Res Comm,19:141–58.
15. Vera A. Wound healing, oral & topical activity of Aloe vera. Journal of the american Podiatric Medical association. 1989;79:559-62.
16. Dagne, E., Bisrat, D., Viljoen, A., & Van Wyk, B. E. (2000). Chemistry of Aloe species. *Current Organic Chemistry*, *4*(10), 1055-1078.
17. Brown, J. P. (1980). A review of the genetic effects of naturally occurring flavonoids, anthraquinones and related compounds. *Mutation Research/Reviews in Genetic Toxicology*, *75*(3), 243-277.
18. Choi, S. W., Son, B. W., Son, Y. S., Park, Y. I., Lee, S. K., & Chung, M. H. (2001). The wound- healing effect of a glycoprotein fraction isolated from aloe vera. *British Journal of Dermatology*, *145*(4), 535-545.
19. Yamaguchi, T., Takamura, H., Matoba, T., & Terao, J. (1998). HPLC method for evaluation of the free radical-scavenging activity of foods by using 1, 1-diphenyl-2-picrylhydrazyl. *Bioscience, biotechnology, and biochemistry*, *62*(6), 1201-1204.
20. Femenia, A., Sánchez, E. S., Simal, S., & Rosselló, C. (1999). Compositional features of polysaccharides from Aloe vera (Aloe barbadensis Miller) plant tissues. *Carbohydrate polymers*, *39*(2), 109-117.
21. Saccù, D., Bogoni, P., & Procida, G. (2001). Aloe exudate: characterization by reversed phase HPLC and headspace GC-MS. *Journal of Agricultural and Food Chemistry*, *49*(10), 4526-4530.
22. Compendium, B. H., & Bradely, P. R. (1992). British Herbal Medicine Association: Bournemouth. *Dorset, UK*, *1*, 22-23.

23. Bruneton, J. (1995). *Pharmacognosy, phytochemistry, medicinal plants*. Lavoisier publishing.
24. Ni, Y., & Tizard, I. R. (2004). Analytical methodology: the gel-analysis of aloe pulp and its derivatives. In *Aloes* (pp. 129-144). CRC Press.
25. Anonymous, Cosmetic Ingredient Review Expert Panel.(2007). "Final Report on the Safety Assessment of *Aloe andon-gensis* Extract, *Aloe andongensis* Leaf Juice, *Aloe arbor-escens* Leaf Extract, *Aloe arborescens* Leaf Juice, *Aloe arborescens* Leaf Protoplasts, *Aloe barbadensis* Flower Extract, *Aloe barbadensis* Leaf, *Aloe barbadensis* Leaf Extract, *Aloe barbadensis* Leaf Juice, *Aloe barbadensis* Leaf Polysaccharides, *Aloe barbadensis* Leaf Water, *Aloe ferox* Leaf Extract, *Aloe ferox* Leaf Juice, and *Aloe ferox*Leaf Juice Extract," *International Journal of Toxicology*, 1-50.
26. Reynolds, T., & Dweck, A. C. (1999). Aloe vera leaf gel: a review update. *Journal of ethnopharmacology*, *68*(1-3), 3-37.
27. Vogler, B. K., & Ernst, E. (1999). Aloe vera: a systematic review of its clinical effectiveness. *Br J Gen Pract*, *49*(447), 823-828.
28. Townsend, J. (1998). Aloe vera. The UK reference guide to complimentary medicine.
29. Atherton, P. (1998). Aloe vera: magic or medicine?. *Nursing Standard (through 2013)*, *12*(41), 49.
30. Shelton, R. M. (1991). Aloe vera: its chemical and therapeutic properties. *International journal of dermatology*, *30*(10), 679-683.
31. Hayes, S. M. (1999). Lichen planus--report of successful treatment with aloe vera. *General dentistry*, *47*(3), 268.
32. Djeraba, A., & Quere, P. (2000). In vivo macrophage activation in chickens with Acemannan, a complex carbohydrate extracted from Aloe vera. *International journal of immunopharmacology*, *22*(5), 365-372.
33. Lee, J. K., Lee, M. K., Yun, Y. P., Kim, Y., Kim, J. S., Kim, Y. S., ... & Lee, C. K. (2001). Acemannan purified from Aloe vera induces phenotypic and functional maturation of immature dendritic cells. *International Immunopharmacology*, *1*(7), 1275-1284.
34. National standard Research collaboration.(2014). Aloe (aloe vera). Mayo clinic web site.http://www.mayoclinic.org/drugs-supplements/aloe/background/hrb-20058665.Updated November1, 2013. Accessed April 24, 2014.
35. Kim, H. S., & Lee, B. M. (1997). Inhibition of benzo [a] pyrene-DNA adduct formation by Aloe barbadensis Miller. *Carcinogenesis*, *18*(4), 771-776.
36. Chaurasia, A. K., Dubey, S. O., & Ojha, J. K. (1994). Role of Vijaysara and Jarul on insulin dependent diabetes mellitus. *Aryavaidyan*, *7*(3), 147-152.
37. Rodriguez-Bigas, M., Cruz, N. I., & Suarez, A. (1988). Comparative evaluation of aloe vera in the management of burn wounds in guinea pigs. *Plastic and reconstructive surgery*, *8*
38. Muller, M. J., Hollyoak, M. A., Moaveni, Z., Brown, T. L. H., Herndon, D. N., & Heggers, J. P. (2003). Retardation of wound healing by silver sulfadiazine is reversed by Aloe vera and nystatin. *Burns*, *29*(8), 834-836.
39. McCauley, R. L., Li, Y. Y., Poole, B., Evans, M. J., Robson, M. C., Heggers, J. P., & Herndon, D. N. (1992). Differential inhibition of human basal keratinocyte growth to silver sulfadiazine and mafenide acetate. *Journal of Surgical Research*, *52*(3), 276-285.
40. Somboonwong, J., Thanamittramanee, S., Jariyapongskul, A., & Patumraj, S. (2000). Therapeutic effects of Aloe vera on cutaneous microcirculation and wound healing in second degree burn model in rats. *Journal of the Medical Association of Thailand= Chotmaihet thangphaet*, *83*(4), 417-425.
41. Chithra, P., Sajithlal, G. B., & Chandrakasan, G. (1998). Influence of Aloe vera on the healing of dermal wounds in diabetic rats. *Journal of ethnopharmacology*, *59*(3), 195-201.
42. Chrubasik, J. E., Roufogalis, B. D., Wagner, H., & Chrubasik, S. (2007). A comprehensive review on the stinging nettle effect and efficacy profiles. Part II: urticae radix. *Phytomedicine*, *14*(7-8), 568-579.
43. Udupa, S. L., Udupa, A. L., & Kulkarni, D. R. (1994). Anti-inflammatory and wound healing properties of Aloe vera. *Fitoterapia*, *65*(2), 141-145.
44. Khorasani, G., Hosseinimehr, S. J., Azadbakht, M., Zamani, A., & Mahdavi, M. R. (2009). Aloe versus silver sulfadiazine creams for second-degree burns: a randomized controlled study. *Surgery today*, *39*(7), 587-591.
45. Heggers, J.P., Pelley, R.P., Hill, D.P. (1992). Wound healing with aloe substances. Academic/Industry Joint Conference,
46. Mohammad, R. A., Motahhare, A.(2014). Mohsen Saberi Extract and Silver Sulfadiazine in Burn Injuries in Experimental Rat Model www.wjps.ir /Vol.3/No.1/January, 29
47. Gupta, N., Jain, U. (2010). Prominent wound healing properties of indigenous medicines. Journal of Natural Pharmaceuticals, *1*(1).
48. Syed, T. A., Afzal, M., Ahmad, S. A., Holt, A. H., Ahmad, S. A., & Ahmad, S. H. (1997). Management of genital herpes in men with 0.5% Aloe vera extract in a hydrophilic cream: a placebo-controlled double-blind study. *Journal of Dermatological Treatment*, *8*(2), 99-102.
49. Yeh, G. Y., Eisenberg, D. M., Kaptchuk, T. J., & Phillips, R. S. (2003). Systematic review of herbs

and dietary supplements for glycemic control in diabetes. *Diabetes care*, *26*(4), 1277-1294.
50. Visuthikosol, V., Chowchuen, B., Sukwanarat, Y., Sriurairatana, S., & Boonpucknavig, V. (1995). Effect of aloe vera gel to healing of burn wound a clinical and histologic study. *J Med Assoc Thai*, *78*(8), 403-9.
51. Fulton, J. E. (1990). "The Stimulation of Postdermal Abarasion Wound Healing with Stabilised *Aloe vera* Gel-Poly- thylene Oxide Dressing," *Journal of Dermatologic Surgery & Oncology*, *16*(5), 1990, 460-467.
52. Montaner, J. S., Gill, J., Singer, J., Raboud, J., Arseneau, R., McLean, B. D., ... & Ruedy, J. (1996). Double-blind placebo-controlled pilot trial of acemannan in advanced human immunodeficiency virus disease. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *12*(2), 153-157.
53. Maenthaisong, R., Chaiyakunapruk, N., Niruntraporn, S., & Kongkaew, C. (2007). The efficacy of aloe vera used for burn wound healing: a systematic review. *burns*, *33*(6), 713-718.
54. Visuthikosol, V., Chowchuen, B., Sukwanarat, Y., Sriurairatana, S., & Boonpucknavig, V. (1995). Effect of aloe vera gel to healing of burn wound a clinical and histologic study. *J Med Assoc Thai*, *78*(8), 403-9.
55. Surjushe, A., Vasani, R., & Saple, D. G. (2008). Aloe vera: a short review. *Indian journal of dermatology*, *53*(4), 163.
56. Reynolds, T., & Dweck, A. C. (1999). Aloe vera leaf gel: a review update. *Journal of ethnopharmacology*, *68*(1-3), 3-37.
57. Davis, R. H., Rosenthal, K. Y., Cesario, L. R., & Rouw, G. A. (1989). Processed Aloe vera administered topically inhibits inflammation. *Journal of the American Podiatric Medical Association*, *79*(8), 395-397.
58. Robson, M. C., Stenberg, B. D., & Heggers, J. P. (1990). Wound healing alterations caused by infection. *Clinics in plastic surgery*, *17*(3), 485-492.
59. Gupta, A., Singh, R. L., & Raghubir, R. (2002). Antioxidant status during cutaneous wound healing in immunocompromised rats. *Molecular and cellular biochemistry*, *241*(1-2), 1-7.
60. Strickland, F. M., Pelley, R. P., & Kripke, M. L. (1994). Prevention of ultraviolet radiation-induced suppression of contact and delayed hypersensitivity by Aloe barbadensis gel extract. *Journal of investigative dermatology*, *102*(2), 197-204.
61. Lissoni, P., Giani, L., Zerbini, S., Trabattoni, P., & Rovelli, F. (1998). Biotherapy with the pineal immunomodulating hormone melatonin versus melatonin plus aloe vera in untreatable advanced solid neoplasms. *Natural immunity*, *16*(1), 27-33.
62. Coats, B. C., & Ahola, R. (1979). *The silent healer: A modern study of aloe vera* (pp. 1-302). Coats.
63. Heggers, J. P., Kucukcelebi, A., Stabenau, C. J., Ko, F., Broemeling, L. D., Robson, M. C., & Winters, W. D. (1995). Wound healing effects of Aloe gel and other topical antibacterial agents on rat skin. *Phytotherapy Research*, *9*(6), 455-457.
64. West, D. P., & Zhu, Y. F. (2003). Evaluation of aloe vera gel gloves in the treatment of dry skin associated with occupational exposure. *American Journal of Infection Control*, *31*(1), 40-42.
65. De Rodrıguez, D. J., Hernández-Castillo, D., Rodrıguez-Garcıa, R., & Angulo-Sánchez, J. L. (2005). Antifungal activity in vitro of Aloe vera pulp and liquid fraction against plant pathogenic fungi. *Industrial Crops and Products*, *21*(1), 81-87.
66. Avijgan, M. (2004). Aloe Vera gel as an effective and cheap option for treatment in chronic bed sores. *Journal of Guilan University of Medical Sciences*, *13*(50), 45-51.
67. Maenthaisong, R., Chaiyakunapruk, N., Niruntraporn, S., & Kongkaew, C. (2007). The efficacy of aloe vera used for burn wound healing: a systematic review. *burns*, *33*(6), 713-718.
68. Li, J., Zhang, Y. P., & Kirsner, R. S. (2003). Angiogenesis in wound repair: angiogenic growth factors and the extracellular matrix. *Microscopy research and technique*, *60*(1), 107-114.
69. Yagi, A., Kabash, A., Mizuno, K., Moustafa, S. M., Khalifa, T. I., & Tsuji, H. (2003). Radical scavenging glycoprotein inhibiting cyclooxygenase-2 and thromboxane A2 synthase from aloe vera gel. *Planta Medica*, *69*(03), 269-271.
70. Leitner, M. G., Russo, J. M., & Byrne, M. E. (1989). Wound healing oral and topical activity of Aloe vera.
71. Heggers, J. P., Kucukcelebi, A., Listengarten, D., Stabenau, J., Ko, F., Broemeling, L. D., ... & Winters, W. D. (1996). Beneficial effect of Aloe on wound healing in an excisional wound model. *The Journal of Alternative and Complementary Medicine*, *2*(2), 271-277.
72. Lee, M. J., Yoon, S. H., Lee, S. K., Chung, M. H., Park, Y. I., Sung, C. K., & Kim, K. W. (1996). In vivo Angiogenic Activity of Dichloromethane Extracts of Aloe vera Cel. *약품개발연구지*, *4*, 211-214.
73. Vazquez, B., Avila, G., Segura, D., & Escalante, B. (1996). Antiinflammatory activity of extracts from Aloe vera gel. *Journal of ethnopharmacology*, *55*(1), 69-75.
74. Krishnan, P. (2006). The scientific study of herbal wound healing therapies: Current state of play. *Current Anaesthesia & Critical Care*, *17*(1-2), 21-27.
75. Junger, H., Moore, A. C., & Sorkin, L. S. (2002). Effects of full-thickness burns on nociceptor sensitization in anesthetized rats. *Burns*, *28*(8), 772-777.

76. Danhoff, I.E., McAnally, B.H. (1983). Stabilised Aloe Vera, its effect on human skin cells. Drugs in the Cosmetics Industry, 133, 52-196
77. Davis, R. H., Donato, J. J., Hartman, G. M., & Haas, R. C. (1994). Anti-inflammatory and wound healing activity of a growth substance in Aloe vera. *Journal of the American Podiatric Medical Association*, *84*(2), 77-81.
78. Hayes, S. M. (1999). Lichen planus--report of successful treatment with aloe vera. *General dentistry*, *47*(3), 268.
79. Chithra, P., Sajithlal, G. B., & Chandrakasan, G. (1998). Influence of Aloe vera on the glycosaminoglycans in the matrix of healing dermal wounds in rats. *Journal of ethnopharmacology*, *59*(3), 179-186.
80. Femenia, A., Sánchez, E. S., Simal, S., & Rosselló, C. (1999). Compositional features of polysaccharides from Aloe vera (Aloe barbadensis Miller) plant tissues. *Carbohydrate polymers*, *39*(2), 109-117.
81. Djeraba, A., & Quere, P. (2000). In vivo macrophage activation in chickens with Acemannan, a complex carbohydrate extracted from Aloe vera. *International journal of immunopharmacology*, *22*(5), 365-372.
82. Lee, J. K., Lee, M. K., Yun, Y. P., Kim, Y., Kim, J. S., Kim, Y. S., ... & Lee, C. K. (2001). Acemannan purified from Aloe vera induces phenotypic and functional maturation of immature dendritic cells. *International Immunopharmacology*, *1*(7), 1275-1284.
83. Castleman, M. (1991). "The Healing Herbs," Rodale Press, Emmaus, 42-44.
84. De Witte, P. (1993). Metabolism and pharmacokinetics of anthranoids. *Pharmacology*, *47*(Suppl. 1), 86-97.
85. Ishii, Y., Tanizawa, H., & Takino, Y. (1994). Studies of aloe. V. Mechanism of cathartic effect.(4). *Biological and Pharmaceutical Bulletin*, *17*(5), 651-653.
86. Heggers, J. P., Kucukcelebi, A., Listengarten, D., Stabenau, J., Ko, F., Broemeling, L. D., ... & Winters, W. D. (1996). Beneficial effect of Aloe on wound healing in an excisional wound model. *The Journal of Alternative and Complementary Medicine*, *2*(2), 271-277.
87. Yagi, A., Kabash, A., Mizuno, K., Moustafa, S. M., Khalifa, T. I., & Tsuji, H. (2003). Radical scavenging glycoprotein inhibiting cyclooxygenase-2 and thromboxane A2 synthase from aloe vera gel. *Planta Medica*, *69*(03), 269-271.
88. Yagi, A., Kabash, A., Mizuno, K., Moustafa, S. M., Khalifa, T. I., & Tsuji, H. (2003). Radical scavenging glycoprotein inhibiting cyclooxygenase-2 and thromboxane A2 synthase from aloe vera gel. *Planta Medica*, *69*(03), 269-271.
89. Jia, Y., Zhao, G., & Jia, J. (2008). Preliminary evaluation: the effects of Aloe ferox Miller and Aloe arborescens Miller on wound healing. *Journal of Ethnopharmacology*, *120*(2), 181-189.
90. Cuttle, L., Kempf, M., Kravchuk, O., George, N., Liu, P. Y., Chang, H. E., ... & Kimble, R. M. (2008). The efficacy of Aloe vera, tea tree oil and saliva as first aid treatment for partial thickness burn injuries. *burns*, *34*(8), 1176-1182.
91. Moghbel, A., Ghalambor, A., & Allipanah, S. (2007). Wound healing and toxicity evaluation of Aloe vera cream on outpatients with second degree burns. *Iranian Journal of Pharmaceutical Sciences*, *3*(3), 157-160.
92. Hamman, J. H. (2008). Composition and applications of Aloe vera leaf gel. *Molecules*, *13*(8), 1599-1616.
93. Robson, M. C., Stenberg, B. D., & Heggers, J. P. (1990). Wound healing alterations caused by infection. *Clinics in plastic surgery*, *17*(3), 485-492.