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PHYTOTHERAPY OF WOUNDS: AN OVERVIEW

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Abstract

Wound healing is a complex physiological process which includes highly organized cellular, humoral and molecular mechanisms. Delayed wound healing presents a huge challenge not just for the patient but also for the healthcare system in general. One of the many ways in which this challenge can be tackled is to use herbal medicines and development which have been commonly used for centuries in folk medicine. Many herbal formulations have been reported to accelerate the process of wound healing by enhancing epithelization, neovascularization, formation of granulation tissue, collagen synthesis, wound contraction, tensile strength in experimental wound models. This review gives an overview of experimental pre-clinical studies related to phytotherapeutic approaches to wound healing. It also includes description of medicinal plants and responsible phytoconstituents like tannins and flavonoids used to cure and treat wounds.

Keywords: Phytotherapy, Herbal Formulation, Polyherbal Formulation, Wound Healing Studies, Clinical

Introduction

Damage or disruption to the typical anatomical structure and function is referred to as a wound [1]. Due to its crucial roles as a physical, chemical, and microbiological barrier, skin wound healing is a key phase for survival, culminating in wound closure. It is a fascinating mechanism and represents an evolutionary advantage. [2]. Wounds, particularly burns, have traditionally been treated using human amniotic membranes and frog skin (used

in other parts of the world) [3]. Herbs have been utilized as all-natural treatments for a variety of physiological ailments since ancient times. Their value as a gift from nature to humanity for the treatment of illnesses was recognized in the traditional medical literature. Traditional herbal medicine refers to the use of plants or plant material to cure wounds or diseases, whether in their raw or processed forms. The therapeutic potential of ethnomedicinal medicinal plants is now being examined. Due to the enormous range of secondary metabolites produced by microbial and plant species, natural products and related structures are crucial sources of novel medications. Herb-herb combinations also known as polyherbal therapy have been used in traditional medical practice for thousands of years, yet scientific evidence of their therapeutic benefits is lacking. In comparison to a single medicine, drug combinations frequently show promise in the treatment of diseases. In Western medicine, the idea of pharmacological combinations is well-established, and it has seen a lot of success over the years. It has been demonstrated that both naturally occurring herbs and herbal components combined into specific formulas may interact. These include mutually beneficial interactions, mutual support, mutual restriction, and antagonistic interactions [4].

Experimental and Clinical Studies on Herbal Formulation

India has a long history of using plant-based knowledge to improve healthcare. For the treatment and management of wounds, a number of herbs and medicinal plants were shown to be effective wound healers. Over the years, a variety of herbal products have been employed in the care and treatment of wounds [5]. Commonly referred to as Arjuna, Terminalia arjuna, a member of the Combretaceae family, is a widespread plant that may be found all over India. When applied to wounds, the leaves function as an antiseptic and hasten to heal. Curcuma longa belongs to Zingiberaceae, a tufty perennial herb that grows to a height of about one meter. Thick, heavily branching, and golden-yellow in color, rhizomes are. It is used on wounds as a poultice to prevent cicatrization [6]. When administered topically twice daily to an experimental burn site in rats, an ointment made from the methanol extract of A. aspera leaves significantly accelerated wound healing [7]. When the ability of *Aristolochia saccata* leaf extract to cure wounds was tested, the outcomes were compared to those of positive control. As a result, *A. saccata* can be suggested as a possible source of compounds that treat wounds [8]. *M. charantia* acetonic extract was created and used in gel and cream formulations. On mice that had been intentionally injured, *M.*

charantia gel and cream demonstrated wound healing activity; the *M. charantia* 1% cream formulation was the most successful treatment [9]. In comparison to other groups, the duration of epithelialization was maximum in the excision model, suggesting that the aq. extract of *Morus alba* has superior wound healing activity than the ethanolic extract in terms of breaking strength in the incision model and percentage wound contraction [10]. The wound healing and antimicrobial activity of ethanolic extract of *Hibiscus hirtus* Linn. (HH)was investigated. *Hibiscus hirtus* extract has an effective wound-healing capacity as evidenced by wound contraction and enhanced tensile strength. Excellent antibacterial activity is shown in the *Hibiscus hirtus* extract against numerous species. Our ethanolic extract of *Hibiscus hirtus* has demonstrated good wound healing activity, as demonstrated by several physicals, histological, and biochemical parameters. The significant antimicrobial activity shown may be due to major active constituents present in plants [11]. The purpose of the study was to evaluate the in vivo wound-healing potential of *P. muellerianus's* aqueous aerial component extract (PLE) and its main isolate, geraniin. The wound-healing activity was assessed using excision and incision wound models. PLE (0.25, 0.5, and 1% w/w) and geraniin (0.1, 0.2, and 0.4% w/w) aqueous creams were used to treat the wounds. In comparison to untreated wounds, PLE plus geraniin considerably (p 0.001) increased wound contraction rate and hydroxyproline synthesis. Geraniin and PLE have cytoprotective and wound-healing properties [12].

***Abrus precatorius* Linn.**

The traditional folk medicine plant *Abrus precatorius* Linn. (Hindi name: Gunci and Ratti) belongs to Fabaceae family, is mostly used to cure cancer, skin conditions, and wounds. The author reported that the observed effects were equivalent to those of a standard drug and that the drug's seed extract accelerated pronounced wound contraction, decreased period of epithelialization, decreased time for wound closure, decreased rate of granulation tissue formation, and increased tensile strength [13]. The white seed extract and methanol insoluble fractions of the plant resulted in an early wound healing activity with and without infections. This wound-healing activity is due to the presence of gums, mucilage, tannins, or phenolic compounds in the seeds [14]. It was discovered that *Abrus precatorius* aqueous and ethanol seed extract showed a strong effect on multidrug-resistant bacterial wound isolates in addition to its antibacterial activities. This result supports the folkloric usage of *A. precatorius* leaf extract for treating wounds [15].

***Baliospermum montana* (Willd.) Muell-Arg**This plant belongs to Euphorbiaceae family, locally called as Danti in Hindi and found throughout India. On an excision wound model, the effects of *Baliospermum montanum* ethanolic and petroleum ether extracts were examined. Although the impact was more obvious in the animal treated with ethanolic extract, the petroleum ether extract demonstrated considerable wound healing activity. The complete epithelialization of the excision wound was seen in the furamycetin-treated animal on the 17th day, while in petroleum ether extract animal-treated epithelialization was delayed by 20 days and in the ethanolic extract-treated animal complete epithelialization was delayed by 18 days. In the control animal, the duration of epithelialization was extended up to 25 days [16].

***Caesalpinia sappan* Linn.**

This plant locally called as "Patamg" and belong to Caesalpiniaceae family. The ethanol extract of the plant observed no acute toxicity in mice, and noted its potent anti-inflammatory and wound healing activities. This study supports the traditional use of *C. sappan* for the treatment of inflammatory-related diseases [17].

***Eclipta prostrata* (Linn.) Linn.**

Preliminary qualitative chemical studies were conducted on the ethanolic crude extract of *Eclipta alba* roots and its four distinct crude fractions, petroleum ether, solvent ether, ethyl acetate, and butanol. The presence of sterols, alkaloids, proteins, and tannins was discovered. When compared to the corresponding controls, ethanol extract and its solvent ether, ethyl acetate, and petroleum ether fractions showed considerable wound healing activity [18].

***Euphorbia thymfolia* Linn.**

A member of the Euphorbiaceae family is the species *Euphorbia hirta* Linn. They are referred to as barokhervi, the asthma plant. The *E. hirta* plant is well-known for its therapeutic value among the tribal community. The entire plant is frequently used to treat wounds. This plant has already been found to have a number of pharmacological qualities, including antiseptic, anti-inflammatory, antidiabetic, antispasmodic, antibacterial, antiviral, antifungal, anticonvulsant, nootropic, antifertility, and aphrodisiac effects. By administering an ethanolic extract of the entire *E. hirta* plant orally and topically to diabetic mice, the study evaluated the wound-

healing ability of the animals and found significant wound-healing effects [19]. Due to the presence of polyphenolic and flavonoid components, *Euphorbia hirta* (Euphorbiaceae) has demonstrated antibacterial, antifungal, antiviral, anti-inflammatory, anti-arthritic, and antioxidant effects. The activity of wound healing is assessed using the enhanced flavonoid fraction. A qualitative phytochemical test and quantitative estimation of total flavonoid and polyphenol content were carried out on ethanol, methanol and water extract of *E. hirta* whole plant followed by separation of total flavonoid fraction (EHTF) from methanol extract. *E*pithelialize period was faster and the rate of wound contraction was significantly higher in EHTF-treated groups. Increased tensile strength, wound contraction rate and hydroxyproline content provided strong evidence for would heal properties of *E. hirta* flavonoid. The presence of myricitrin, quercitrin, kaempferol, luteolin, and gallic acid like polyphenolic compounds in *E. hirta* indicated the potential wound-healing property of the plant [20].

***Gardenia gummifer* Linn.f.**

Gardenia gummifera L. (Hindi Name: Dikamali) is a medicinal plant that belongs to the Rubiaceae family. The plant is well known for its traditional practice. The effectiveness of the wound healing and anti-inflammatory properties of *Gardenia gummifera* stem bark methanol extract (GSME) and *Gardenia gummifera* fruit methanol extract (GFME) were assessed. It was found that the wounds treated with GSME and GFME had improved wound contraction, a shorter epithelialization period, and higher tensile strength. The investigations showed that GFME and GSME had notable and significant anti-inflammatory and wound-healing effects [21].

***Jasminum angustifolium* (Linn.) Willd.**

Locally this plant called as “Banmallika” and belongs to Oleaceae family. *Jasminum angustifolium* Linn's ethanol and aqueous extracts were discovered to have powerful wound-healing abilities. This was demonstrated by a shorter time for epithelialization and a faster rate of wound contraction, and it was concluded that *Jasminum angustifolium* linn. might be an effective wound-healing substance [22]. The ethanolic extract of Jasminum grandiflorum Linn. (J. grandiflorum) flowers was tested for its ability to speed up the healing of wounds in diabetic rats, and it was found to significantly increase the wound-breaking strength of both IWs and DWs [23].

***Gossypium barbadensis* Linn.**

The goal of this study was to assess the antibacterial and wound-healing abilities of a methanolic extract of dried, fresh Gossypium barbadense leaves. Using the Well diffusion method, the extract's antibacterial effects were investigated against five wound isolates of Pseudomonas aeruginosa, Staphylococcus aureus, Escherichia coli, Proteus mirabilis, and Shigella sonnei. The results showed that, with the exception of Escherichia coli, the methanolic extract of dried fresh Gossypium barbadense leaves exhibited dose-dependent action. Propylene glycol, the extracting solvent employed as a negative control, had no effect on any of the test organisms. With the exception of Escherichia coli and Pseudomonas aeruginosa, the powder employed as the positive control likewise exhibited dose-dependent action against all of the test species. All of the test organisms' growth was, however, impeded by the concentrated (i.e., undiluted) solution. After ten days of treatment with all test chemicals, it was shown that when the extract was applied at a concentration of 20 mg/ml, there was around 91% wound healing in the rats, whereas approximately 80% healing of wounds in the rats was noticed for powder. The distilled water used as a negative control however produced only about 36 %healing of wounds in the rats. The distilled water-treated group's percentage healing of wounds was significantly different ($p < 0.05$) from those of the extract and antibacterial-treated groups [24].

Jatropha curcas Linn.

Jatropha curcas L. (Hindi Name: Jungali Erand) belongs to Euphorbiaceae family, accelerates the healing process by raising the skin-breaking strength, granulation tissue-breaking strength, wound contraction, dry granulation tissue weight, and hydroxyproline levels in Wistar albino rats when its wound-healing capabilities are tested. The epithelization duration was also significantly shortened, which indicated that the *Jatropha curcas* crude bark extract was quite helpful in hastening the healing process.[25]. The Euphorbiaceae family's *Jatropha curcas* L. stem bark extract was tested for its ability to treat wounds, and it was shown that when compared to the control group, the extract ointment significantly speed up the healing of both wound models. When compared to the control, all indicators, including wound contraction, hydroxyproline content, tensile strength, and histological examinations, revealed substantial alterations. The outcome revealed that the extract ointment exhibits promise for wound healing in both excision and incision models [26].

***Kaempferia galanga* Linn.**

Kaempferia galanga L. (Family: Zingiberaceae) is a plant that is frequently used as a spice in cooking and is also frequently used empirically as a medicine. This plant has been demonstrated to have anti-inflammatory properties by hastening the healing of Wistar rats' chemically-induced oral mucosal ulcers [27]. In Wistar rats, the effect of *Kaempferia galanga* (*K. galanga*) alcohol extract on wound healing and how dexamethasone hindered wound healing were investigated. In this work, three types of wound models' incision, excision, and dead space wounds were utilized. In the incision type of wound model, the dexamethasone, treated group had a substantial decrease in the wound breaking strength when compared to the control group. The breaking strength of the group receiving dexamethasone was dramatically boosted by the coadministration of *K. galanga* and dexamethasone. *K. galanga* significantly improved the percentage of wound contraction in the excision wound model, the percentage of wound contraction was significantly increased by *K. galanga* only on sixteenth day and also it reversed the dexamethasone-suppressed wound contraction on the 16 days. *K. galanga* significantly reduced the time required for epithelialization and reversed the epithelialization delaying effect of dexamethasone significantly [28].

***Lawsonia inermis* Linn.**

This plant known as "Mehanti" in Hindi and belongs to Lythraceae family. Using excision, incision, and dead space wound models on rats, the ethanol extract of *Lawsonia inermis* (200 mg/kg/day) was used to assess the wound healing activity. It was discovered that, when compared to the control and reference standard animals, the group of experimental animals treated with an extract of *L. inermis* displayed: a high rate of wound contraction, a decrease in the period of epithelialization, high skin breaking strength, and a significant increase in the When compared to controls, who had a wound area reduction of 58%, animals treated with extract had a wound area reduction of 71% [29].

***Naravelia zeylanica* (Linn) DC.**

In a study on the effects of *N. zeylanica* (Dhanavalli) leaf extracts on the healing of wounds in wistar rats, it was discovered that both the aqueous and ethanol extracts significantly accelerated the healing of all the wound models tested. When compared to the control group of animals, the treated animals showed higher wound healing rates,

shorter epithelialization times, higher skin breaking and granulation strengths, and higher dry granulation tissue weight. In treated mice, hydroxyproline, protein, and collagen contents all increased significantly while lipid peroxide levels decreased. The findings also supported the test extracts' strong wound healing properties. In comparison to the aqueous extract, the ethanol extract of *N. zeylanica* has superior wound healing properties [30].

***Tamarindus indica* Linn**.

The Indian medical system recommends *Tamarindus indica* Linn. (Imli) for the treatment of wounds. An investigation was made into the *Tamarindus indica* Linn. cork and seed ash's capacity to heal wounds in Wistar albino rats. When compared to the normal control, the groups that received the test treatment demonstrated a substantial reduction in the duration of epithelialization and the percentage of wound contraction. *Tamarindus indica* Linn. cork ash has significantly increased wound contraction percentage [31].

Ten rabbits were used in the study to test the influence of tamarind fruit paste on the rate of wound healing. The results showed that tamarind treatment resulted in a faster rate of wound closure than the control group. It was determined that tamarind fruit paste may aid in wound healing by promoting epithelial migration and re-epithelialization, hastening wound closure, and speeding wound closure [32].

***Ziziphus oenoplia* (Linn.) Mill.**

The plant found throughout India and known as “Makkay” belongs to family Rhamnaceae. Rats were used in the evaluation of the aqueous and alcoholic extracts of the fruits of *Zizyphus Oenoplia* for excision, incision, and dead space wound models. The results showed that the animals treated with the extracts had significantly shorter times for epithelialization, significantly higher tensile strengths, and significantly stronger granulomas. When compared to the control, alcoholic and then aqueous extracts showed significant action. It was determined from the investigation that both extracts had high wound-healing potential [33].

Polyherbal formulation

The Polyherbal Ayurvedic preparation Tiktadya Ghrutam is applied topically to all types of wounds in Ayurveda. Tiktadya Ghrutam has antibacterial action, making it a very effective wound healer. The plants *Curcuma longa, Azadirachta indica, Jasminum auriculatum*, and *Pongamia glabra* are the main ingredients in this mixture [34].

In comparison to the control group, the created polyherbal formulation in the form of an ointment that contained hydroalcoholic extracts of *Ficus religiosa*, *Mentha arvensis*, and *Rauwolfia serpentina* roots significantly accelerated wound healing. In terms of contractibility, wound closure time, and tensile strength, the obtained results were almost directly compared with standard drug group betadine ointment [35]. An ointment containing *A. officinalis* extract, *R. x damascena* essential oil (2% essence), and *L. officinalis* essential oil (2% essence) in a eucerin base (20:20:10:50) was created to test the polyherbal formulation's ability to cure wounds. The polyherbal formulation group experienced a much higher percentage of recovery than the other groups. Due to the inhibition of inflammatory mediators, this polyherbal mixture may have wound healing properties [36]. Six polyherbal ointments containing methanol leaf extracts of *Ageratum conyzoides* Linn. (Asteraceae), *Argemone mexicana* Linn. (Papaveraceae), *Heliotropium indicum* Linn. (Boraginaceae) and bark extract of *Alstonia scholaris* (L.) R. Brown. (Apocynaceae) were formulated and tested for wound healing activity in rats using excision and incision wound models and skin irritation study. Nitrofurazone (0.2% w/w) in respective ointment bases was used as reference standard for the activity comparison. All the groups of animals treated with various formulations exhibited significant activity [37]. The antimicrobial and antioxidant effects of a developed polyherbal drug made from methanolic extracts of *Plumbago zeylanica* Linn, *Datura stramonium* Linn, and *Argemone mexicana* Linn were assessed, and the ratio of the individual plant extracts was then optimized in accordance with the results to treat the wound. Through rapid remodelling of injured tissue, the antibacterial and anti-inflammatory activity of Polyherbal medication induced and encouraged the wound healing process [38]. The polyherbal and *Euphorbia hirta* formulations' capacity to promote wound healing was evaluated and prepared polyherbal formulation for wound healing that contains equal amounts of the dried rhizomes of *Tridax procumbens, Euphorbia hirta, Eclipta alba*, and *Aloe barbadensis* gel. Author reported that the significant wound healing activity was discovered in topical and oral formulations [39]. The traditional wound healer herbs *Clinacanthus nutans* and *Elephantopus scaber* are used to develop a new polyherbal formulation in the treatment of wounds and identified flavonoids from them may responsible for its activity as wound healing [40]. Three gel formulations of Carbopol 940 containing an *Azadirachta indica* leaf ethanol extract in three distinct concentrations, i.e., 1, 2, and 3% w/w, were developed. These formulations were tested for their ability to speed up the healing process of wounds. It should be noted that the gel formulation containing 3% w/w Azadirachta indica extract sped up the wound healing

process, suggesting that this formulation is a good candidate for wound healing [41]. The ethanol extracts of *Argemone mexicana*, *Cassia tora,* Evolvulus asinoides, Ocimum centum, and Curcumis *sativus* were used to create the herbal cream compositions. Herbal ethanolic extracts were mixed with a cream base, which was made using the phase-inversion emulsification method. In comparison to the control formulation therapy, which had an epithelialization duration of 18.3 days, application of the herbal cream formulation containing the *Argemone mexicana* L. extract (1.0 g/100g ointment) achieved the best rate of wound healing. For the most efficient and secure application in the process of healing wounds, *A. maxicana* L. extracts (0.1g/100g of cream base) are formulated into a herbal cream [42]. Wound healing activity of *S. rhombifolia* leaves was investigated in mice using 50%, 33% and 25% formulated 80% ethanolic leaves extract ointment and water preparations and noted that the formulated ointments and the water preparations of *S. rhombifolia* leaves have a potential benefit in enhancing wound healing [43]. Rats were used to test the effectiveness of a phytosome gel made from the petroleum ether extract of the root bark of *Onosma echiodes* for the treatment of wounds. By using the thin film hydration process, phytosome (equal to 2% w/w of naphthoquinones) of the standardized extract were created. Rats' wound healing activity significantly improved in the group that received the formulation treatment. [44]. In earlier studies utilising excision wound models, herbal extracts of *Emblica officinalis Gaertn*, *Vitex negundo* L., and *Tridax procumbens* L. showed rapid skin regeneration, wound contraction, and collagen formation at the site of injury. Cell mobilisation in response to aqueous plant extracts and their formulation on the L929 fibroblastic cell line and the HaCaT keratinocyte cell line was observed in the current experiment. It was found that the formulation had high concentrations of flavonoids, tannins, and phenols, all of which promote healing. The fast skin regeneration and wound healing of a polyherbal mixture. A polyherbal formulation created from plant extracts has been demonstrated to hasten wound healing by promoting fibroblast and keratinocyte proliferation and migration as well as angiogenesis at the site of injury [45]. A polyherbal ointment made of methanolic extracts of the leaves of *Tectona grandis*, *Ficus religiosa*, and *Caesalpinia pulcherrima* was designed, formulated and evaluated by using excision and incision models, the parameters for wound healing. As a benchmark, nitrofurazone (0.2 w/w) was employed. The poly herbal ointment revealed that it might be used as a potential herbal formulation for wound healing due to the synergistic activity of the phytoconstituents included in the extracts [46]. On the ability to heal wounds using an excision wound model and to reduce inflammation using a

formalin-induced paw edoema method, the effects of poly-herbal formulations containing extracts of *Zingiber officinale*, *Curcuma longa*, *Aloe barbadensis*, *Citrus aurantium*, and *Emblica officinalis* were evaluated. The wound area was significantly reduced in all of the ointment formulations that contained 2, 4, and 6% w/w of extracts. Results from 6% w/w ointment were superior to those from 2 and 4% w/w. These outcomes were contrasted with those of the typical framycetin. At doses of 100, 300, and 500 mg/kg, the anti-inflammatory effects of three different poly-herbal formulations—poly-herbal formulation-1, poly-herbal formulation-2, and poly-herbal formulation-3—were examined. All poly-herbal formulations considerably reduced the edoema that formalin produces in rat paws. Poly-herbal formulation 3 displayed higher inhibition than poly-herbal formulations 1 and 2. These results were consistent with those of diclofenac generic. Poly-herbal formulations are less harmful and more effective at treating inflammation and wounds, according to historical and contemporary research [47]. Rat Excision and Incision wound models were used to test the efficacy of the newly created polyherbal formulations (Ointment and Gel). When compared to the normal Betadine Ointment and control groups in the excision wound model, the polyherbal Ointment treated group showed a 100% reduction in wound area on day 20 and had a faster rate of epithelization. A substantial increase in tensile strength was seen in the group treated with ointment in the incision wound model. In each case, the wound area gradually shrank over time, demonstrating the effectiveness of the formulations in mending the caused wounds. According to reports, the novel polyherbal formulations have strong wound healing properties and could be an effective treatment option for wound healing [48]. A herbal ointment (BILOE-8) prepared from *Aloe barbadensis* and *Bidens pilosa* is the subject of this study, which also aims to evaluate its quality, wound-healing efficiency, and toxicity profile. Fusion resulted in the creation of BILOE-8. BILOE-8 demonstrated the quickest rate of wound reduction, as well as the quickest epithelialization and healing times, when compared to the other therapies. There were no cutaneous changes within 24 hours. As a result, an aloe-based herbal ointment is an effective wound remedy that can be utilised instead of traditional treatments [49].

Phytoconstituents responsible for wound healing activity

One of the primary phytochemicals present in many higher plants are tannins, which are polyphenols with a wide range of chemical composition. Tannins can bind to proteins (and subsequently precipitate proteins) by effectively

forming potent complexes with proteins and other macromolecules. Tannins are thought to provide a variety of pharmacotherapeutic actions. Due to their anti-hemorrhagic and antiseptic properties, they are effective as an anti-inflammatory agent and in the treatment of burns and other wounds [50]. Fruits, vegetables, grains, bark, roots, stems, flowers, tea, and wine all contain flavonoids, a class of organic compounds with varying phenolic structures [51]. Flavonoid increases the antioxidant activity that surges the rate of wound contraction and works synergistically with other bioactive compounds [52].

Conclusions

Many medicinal plants and herbal formulations developed from plants are most commonly used in various parts of worlds. Herbal formulations provide treatment of diseases in a holistic approach by using concepts of traditional medicinal systems. The scientific advancement carries with it the improvement in Ayurvedic herbal formulations, through the study of various phytoconstituents and discovery of useful herbs combinations which work synergistically to produce desirable effect., but still the scientific evidence is lacking. There is need of time to evaluate herbal formulation using scientific methods such as human clinical trial, possible bioactive compounds and mechanism of action for the future world.

Conflict of Interest

The authors declare no conflict of interest.

References

1) Velnar T, Bailey T, Smrkolj V. 2009. The Wound Healing Process: An Overview of the Cellular and Molecular Mechanisms. The Journal of International Medical Research, 37(5): 1528-1542. DOI: 10.1177/147323000903700531.
2) Heiko S, Daniel J. T, Stephan H, Jorg H, Ursula M. 2017. Skin Wound Healing: An Update on the Current Knowledge and Concepts. European Surgical Research, DOI 58: 81–94. DOI: 10.1159/000454919.
3) Shankar M, Ramesh B, Roopa Kumar D, Niranjan Babu M. 2014. Wound healing and it's importance-A Review. Der Pharmacologia Sinica, 1(1):24-30.
4) Muhammad Shahzad A, Muhammad Syarhabil A, Awang Soh M, Muhammad Zamharir A, Faridah S. 2016. An Update Review on Polyherbal Formulation: A Global Perspective. Systematic Reviews in Pharmacy., 7(1):35-41. DOI : 10.5530/srp.2016.7.5
5) Prafulla S, Bhargav B, Chirag P, Vidya S. 2012. An overview of medicinal plants as wound healers. Journal of Applied Pharmaceutical Science, 2 (11);143-150. DOI: 10.7324/JAPS.2012.21127

6) M. Ismail S, P. Jagan Mohan R, Gopinath S. M., Dayananda K. S., Ajay M, Purushotham K. 2014. Evaluation of wound healing activity of polyherbal formulation of roots of *Terminalia Arjuna*. International Journal of Innovative Research in Science, Engineering and Technology, 3(3) Smita J and U.K. Patil, Formulation and Characterization of Poly Herbal Cream with Wound Healing Activity. Pharmacologyonline, 3: 1470-1477. 10097-10100. DOI: 13.232.72.61:8080/jspui/handle/123456789/2239.
7) Chandana C B, Archana T, Shameem Ara B, Debesh Chandra P, Dilip Kumar S, Rumi Saikia B, Asheesh G. 2012. In vivo wound-healing efficacy and antioxidant activity of Achyranthes aspera in experimental burns. Pharmaceutical Biology, 50(7): 892-899. DOI: doi.org/10.3109/13880209.2011.642885
8) Srinivasa Rao B, Abeer Mohammed Al-S, Reem Yousuf Al-J, Janardhana Papayya B, Padma Kanchi R, Vishnu Priya V, Aruthra Arumugam P, Shiva Shankar Reddy G, Joel Palpath J, Krishna Mohan S. 2019. In vitro wound healing potency of methanolic leaf extract of *Aristolochia saccata* is possibly mediated by its stimulatory effect on collagen-1 expression Heliyon, 5(5): e01648. DOI:https://doi.org/10.1016/j.heliyon.2019.e01648
9) William A G, Carmen R, Silva C, Julio H V. 2021. Wound healing by topical application of *Momordica charantia* L. formulations on mice. Veterinary World, 14(10): 2699-2704. DOI: www.doi.or/10.14202/vetworld.2021.2699-2704.
10) Manish K, Aditi K, Krishna M. 2013. Exploration of Healing Promoting Potentials of Leaves of *Morus alba* L. in Albino Rats. American Journal of Pharmacology and Toxicology, 8 (3): 95-101. **DOI:** https://doi.org/10.3844/ajptsp.2013.95.101
11) Kakaraparthy R, Garlanka Venkata N K, Yejella Rajendra P, Lankadi Devi B. 2018. Wound healing activity in rabbits and antimicrobial activity of *Hibiscus hirtus* ethanolic extract. J. Pharm. Sci., 54(4):e17075, 1-12.DOI: https://doi.org/10.1590/s2175-97902018000417075
12) Yaw D. Boakye, Christian A, George P. Ayande, Nicholas Titiloye, Emmanuel A. Asiamah and Kwabena O. Danquah.2018. Assessment of Wound-Healing Properties of Medicinal Plants: The Case of *Phyllanthus muellerianus*, Frontier in Pharmacology, 09: 945. DOI: https://doi.org/10.3389/fphar.2018.00945
13) M. Sudaroli and Tapan Chatterjee. 2009. Evaluation of wound healing activity of red and white seed varieties of *Abrus precatorius* Linn. Extracts on rats, Pharmacologyonline,3: 175-192.
14) R. Sivakumar, C. Alagesaboopathi. 2011. Studies on wound healing activity of red and black colored seed, white colored seed extract of *Abrus* precatorius L., International Journal of Pharma and Bio Sciences, 2(1): 302-312.
15) Oka Chiamaka U, Nweze Emeka I. 2020. Antibacterial precatorius Linn., leaf extract against multi resistant wound bacterial isolates, Research Journal of Medicinal Plants, 14(2: 88-89.
16) Hemant Kumar, S.K. Jain, Nandlal Singh, Vihangesh D, Pankaj Singh. 2011. Wound healing activity of the plant of *Baliospermum montanum* willd., IJPSR, Vol. 2(4): 1073-1076.
17) Supinya Tewtrakul, Pattreeya Tungcharoen, Teeratad Sudsai, Chatchanok Karalai. 2015. Antiinflammatory and wound healing effects of *Caesalpinia sappan* Linn, Phytother Res, 29(6); 850.
18) M.B.Patil, S.S. Jalalpure, V.. Nagoor,.2004. Wound healing activity of the roots of *Eclipta alba* Linn., Indian drugs, 41(1): 40-45.
19) Riazul Haque Tuhin, Marium Begum, Sohanur Rahman, Rubaba Karim, Taslima Begum, Siraj Uddin Ahmed, Ronia Mostofa, Amir Hossain. 2017. Wound healing effect of *Euphorbia hirta* linn. (Euphorbiaceae) in alloxan induced diabetic rats BMC Complement Altern Med., 17: 423.
20) Papiya Bigoniya, Sourabh Agrawal, Neelesh K. 2013. Potential Wound Healing Activity of *Euphorbia hirta* Linn Total Flavonoid Fraction. Int. J. Pharm. Sci. Rev. Res. 22(2): 149-156,
21) Vinay Kumar, Riaz Mahmood,Krishna V., Ajith Bhat. 2021. In vitro Anti-inflammatory and In vivo Wound Healing Activity of *Gardenia gummifera* L.f Fruit and Stem bark Methanol Extracts in Rats, International Journal of Pharmaceutical Research. 13(1): 3124-3130.
22) Sonam Kukloria, Singune Shantilal, Bele, D.S, Kukloria Gagan. 2018. Evaluation of in vivo Wound healing activity of *Jasminum angustifolium* linn on excision wound model in rats. Int J Pharm, 8(4): 38-69.

23) B S Nayak, Krishna Mohan. 2007. Influence of ethanolic extract of *Jasminum grandflorum* linn flower on wound healing activity in rats. Indian J Physiol Pharmacol, 51(2): 189-94.
24) E.Ikobi, C.I.Igwilo, Olufunsho Awodele, Chukwuemeka P Azubuike. 2012. Antibacterial and wound healing properties of methanolic extract of dried fresh Gossypium barbadense leaves, Asian Journal of Biomedical and Pharmaceutical Sciences, 2012, 2(13): 32-37.
25) Somashekar Shetty , Saraswati L Udupa, Alaya L Udupa, Venkata R Vollala. 2006. Wound healing activities of bark extract of Jatropha curcus Linn. In albino rats, Saudi Med J., 27(10): 1473-6.
26) Kamal Sachdeva, Preeti Garg, Manmohan sighal, Birendra Srivastava. 2011. Wound Healing Potential of Extract of *Jatropha curcas* L. (Stem bark) in rats, Pharmacognosy Journal, 3(25): 67-72.
27) Wahyuni IS, Sufiawati I, Nittayananta W, Levita J. 2022. Anti-Inflammatory Activity and Wound Healing Effect of *Kaempferia galanga* L. Rhizome on the Chemical-Induced Oral Mucosal Ulcer in Wistar Rat, Journal of Inflammation Research, 15: 2281-2294.
28) V Tara Shanbhag, Sharma Chandrakala, Adiga Sachidananda,Bairy Laxminarayana Kurady, Shenoy Smita, Shenoy Ganesh. 2006. Wound healing activity of alcoholic extract of *Kaempferia galanga* in Wistar rats, Indian J Physiol Pharmacol, 50(4): 384-90.
29) B Shivananda Nayak, Godwin Isitor, E M Davis, G K Pillai. 2007. The evidence based wound healing activity of *Lawsonia inermis* Linn., Phytother Res, 21(9):827-31.
30) Ashoka Shenoy M., Sridevi G. and C. S. Shastry. 2009. Evaluation of wound healing activity of *Naravelia zeylanica* leaves. Int. J. Chem. Sci. 7(3): 1857-1866.
31) Thejaswi I Naik, Shrikanth P, Ravi Mundugaru, Shridhara Bairy Thejaswi et al. 2017. In vivo study Wound healing activity of *Tamarindus indica* Linn. seed and cork ash. J Ayu Med Sci, 2(1): 129-35.
32) M. O. Attah, H. B. Ishaya, M. S. Chiroma, D.S. Amaza, S. U. Balogun and T.W. Jack. 2015. Effect of *Tamarindus indica* (Linn) on the Rate of Wound Healing in Adult Rabbits. IOSR Journal of Dental and Medical Sciences 14 (8): 80-84.
33) I.J. Kuppast, K.V. Kumar.2012. Wound healing activity of aqueous and alcoholic extrcts of fruits of *Zizyphus oenoplia*. International Journal of Chemical Sciences, 10(2):1021-1027
34) Dinesh G, Sohan L S, Titiksha S. 2017. Review Article Antimicrobial Potential of Polyherbal Formulation Tiktadya Ghrutam - A Review, International Journal of Research & Review. 29(4): 10.
35) Rajput R T, Gohil K J, Singh P and Singh S. 2015. Development of wound healing herbal formulation "HERBAL WOUND GUARD" International Journal of Scientific and Research Publications, 5(3): 1-5.
36) Saeideh M, Amir Hossein A, Eghbal J, Bahman Y, Saeed E, Alireza A, Mohammad A. 2021. Evaluation of wound healing and anti -inflammatory activities of a herbal ointment consisting of *Althaea officinalis*, *Lavandula angustifolia*, and *Rosa x damascena* in animal excision wound model, J. Med. Plants, 20 (77): 37 -49.
37) G. K. Dash and P. N. Murthy. 2011. The wound healing effects of a new polyherbal formulation, Der Pharmacia Lettre, 3(1): 342-349.
38) Suresh Kumar D, P.K. Choudhury, Rajnish S, Maya S. 2019. Antimicrobial, anti-inflammatory and wound healing activity of polyherbal formulation Biomedicine & Pharmacotherapy, 111: 555-567. DOI: 10.1016/j.biopha.2018.12.075
39) Kuldeep G, A. K. Pathak.2013. Evaluation of wound healing activity of the polyherbal and *Euphorbia hirta* formulations. Afr. J. Pharm. Pharmacol, 334. DOI:www.doi.org/10.5897/AJPP12.1276
40) Muhammad Shahzad A, Muhammad Syarhabi A, Awang Soh M. 2016. Phytochemical Evaluation of polyherbal formulation of *Clinacanthus nutas* and *Elephantopus scaber* to identify flavonoids. Pharmacogn Journal, 8(6): 534-541.
41) Mughisa M, Syed Nisar Hussain S, Uzma A, Farhan Ahmed K, Asma Z, Syed Majid B, Ghulam M. 2021. An assessment of the wound healing potential of a herbal gel containing an *Azadirachta indica* leaf extract. Veterinary Medicine, 66 (03): 99–109.
42) Smita J and U.K. Patil. 2011. Formulation and Characterization of Poly Herbal Cream with Wound Healing Activity. Pharmacologyonline, 3: 1470-1477.
43) Patrick F, Pax M, Amos R. M. 2018. Evaluation of the wound healing activity of formulated ointments and water preparation from *Sida rhombifolia* leaf extract Tanzania Journal of Health Research. 2018; 20(4): 1-8. **DOI:** 10.4314/thrb.v20i4.4

44) Jeeja P, Chhaya G. 2021. In-Vivo Evaluation of Phytosomal Gel of The Petroleum Ether Extract of Root Bark of *Onosma echiodes*. Indonesian Journal of Pharmacy Indonesian J Pharm, 32(4):474-483.

45) Yogesh P. Talekar, Kishori G. Apte, Shubhangi V. Paygude, Prasad R. Tondare, Pradeep B. Parab. 2017. Studies on wound healing potential of polyherbal formulation using in vitro and in vivo assays, Journal of Ayurveda and Integrative Medicine, 8: 73-81. DOI: 10.1016/j.jaim.2016.11.007

46) Kavitha AN, Deepthi V and Naira Nayeem. 2013. Design, formulation and evaluation of a polyherbal ointment for its wound healing activity. Pharmacophore, 4 (5): 175-180.

47) K. Soujanya, K. Srinivas R, D. Kumara S, G. Vishwanath R, P. Girija, K. Sirisha. 2020. Evaluation of Wound healing and Antiinflammatory Activities of New Poly-herbal Formulations. Indian Journal of Pharmaceutical Sciences, 173-178.

48) Ansar M. P, Santosh M. K, R. V. S, Vijay N. R. Vinod V. T. 2013. Formulation and Evaluation of New Polyherbal Formulations for Their Wound Healing Activity in Rat, International Journal of Pharmaceutical Research & Allied Sciences, 2(2): 66-69.

49) Sandra N, Stephen L, Grace N, Gerald A, Irene A, Charles S, Gladys Mercy T, Raphael W, Bruhan K, Pakoyo Fadhiru K, David Musoke-M, Patrick Ogwang E. 2018. Formulation, Development and Validation of a Wound Healing Herbal Ointment from Extracts of *Bidens pilosa* and *Aloe barbadensis*. Journal of Pharmacy and Pharmacology Research, 2 (2): 032-038. DOI: 10.26502/jppr.0008. 26

50) Pius O. U, Egbuonu A. C. C, Obasi L. N, Ejikeme P. M. 2011. Tannins and other phytochemical of the *Samanaea saman* pods and their antimicrobial activities, African Journal of Pure and Applied Chemistry, 5(8): 237-244.

51) A. N. Panche, A. D. Diwan, S. R. Chandra. 2016. Flavonoids: an overview. Journal of Nutritional Science, 5(47):1-15 doi:10.1017/jns.2016.41.

52) Muhammad Shahzad A, Muhammad Syarhabil A, Awang Soh M, Muhammad Zamharir A, and Faridah S. 2016. Antioxidant and Wound Healing Activity of Polyherbal Fractions of *Clinacanthus nutans* and *Elephantopus scaber*. Evidence-Based Complementary and Alternative Medicine, 11:14. DOI: https://doi.org/10.1155/2016/4685246