Essential Oils Enhanced Performance for Wound Healing: A Critical Review

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Abstract: Numerous people around the world experience chronic wounds. Strong evidence for the anti-inflammatory and antimicrobial activity effects of essential oils (EO) is widely documented in the literature, and their chemical make-up is well understood.

In this article, we will discuss the evidence for essential oil in artificial wounds and the potential for combining it with biopolymers frequently employed in skin regeneration. Rodent wounds responded favorably to treatments using essential oils from the species Lavandula, Eucalyptus, marigold, tea tree, and clove. These EO were all mostly made of monoterpenoids. There is substantial data supporting the effectiveness of EO in the treatment of wounds.

Keywords: wound healing, essential oil, terpenoid and lavender oil

INTRODUCTION

If skin is damaged, a series of biochemical activities are carried out to repair the tissue's structure and function. This process is known as wound healing. For the restoration of normal skin, four overlapping phases—blood clotting, inflammation, new tissue development, and tissue remodeling—must be completed. The latter two phases include intricate processes like cellular proliferation, collagen synthesis, and the development of granulation tissue, as well as matrix disintegration and the addition of new collagen, along with wound contraction and scarring.[1]

Dressings are quite ideal to increase the early phases of the healing process but are insufficient to achieve the last two when there is considerable dermo-epidermal skin loss, such as from a serious burn.[2]

Over the past few decades, research and development of dressings and scaffolds have been encouraged by the challenge of creating an artefact that permits wound healing in both chronic and acute wounds. It is important to note that chronic wounds are seen as a significant burden globally due to the sheer number of affected individuals as well as the variety of stages and complexity associated with the term "chronic wound." In fact, millions of people worldwide who have chronic wounds are still generally in the inflammatory phase, which interferes with their daily activities and lowers their quality of life. These lesions include a variety of aetiologies, including diabetic, venous, pressure, and chronic lower extremity ulcers, all of which have significant social and economic repercussions.[3]

One of the most intricate physiological processes is wound repair, which involves numerous diverse cell types whose contributions are strictly controlled over time. Such a complicated path's failure could prevent wounds from healing, resulting in nonhealing wounds [4]. The normal course of wound healing involves overlapping stages of inflammation, the production of new tissue, and the subsequent remodelling of newly produced tissue. The duration of these stages ranges from minutes (early clotting and coagulation) to several months or even years, which is a striking contrast in timelines. In older people, particularly those with diabetes mellitus and vascular disorders, chronic wounds—including venous leg ulcers, diabetic foot ulcers, arterial insufficiency, and pressure ulcers—determine serious morbidity and even fatality. Burn wounds are separated into three overlapping zones.5 Complete necrosis, mainly centralized, characterizes the zone of coagulation [5]. The hyperemic area, which will recover in the absence of additional attacks, is primarily found outside. The zone of stasis, which is between the hyperemia and coagulation zones, has progression determined at this point. The copyright for this article is reserved. over the initial days following injury, in accordance with its perfusion. The stasis zone could turn into necrosis, which would cause the wound to become deeper and wider.

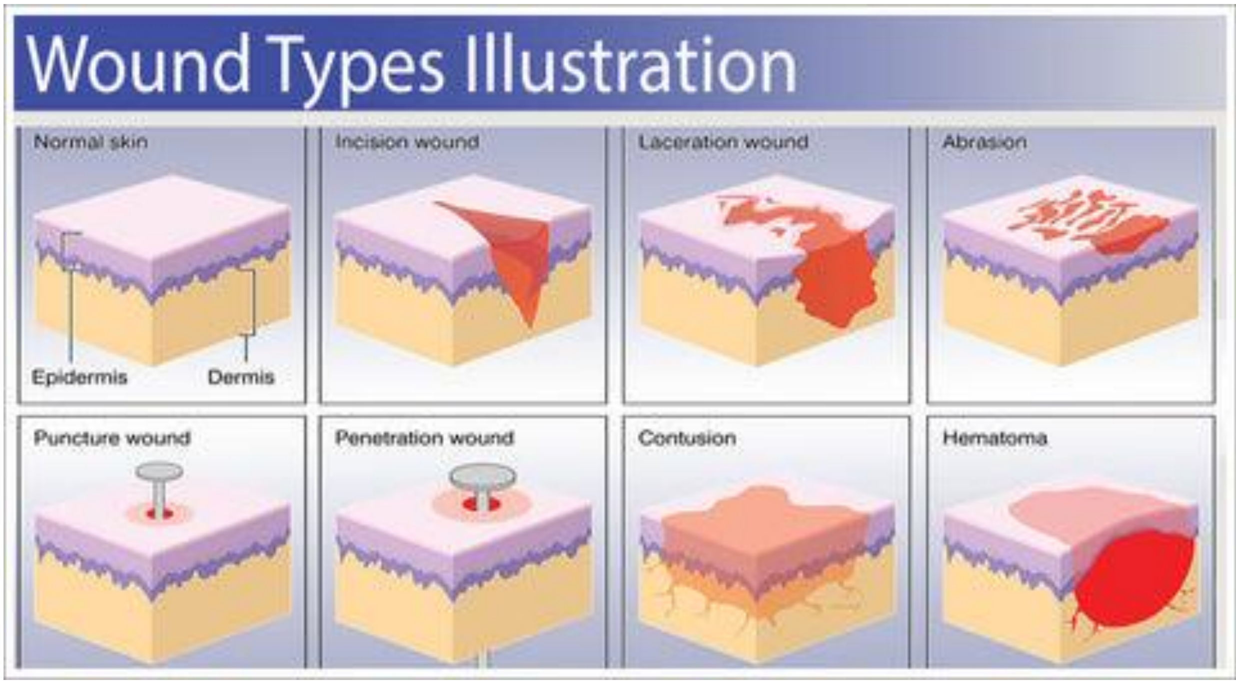

Fig no. 1 – Types of wound

Finding the best dressings for each specific type of chronic wound is a current concern according to their various stages. Additionally, novel therapeutic drugs made specifically for managing diabetic wounds are needed. With this objective in mind, current research is concentrated on the incorporation of biological material, such as stem cells or vegetable extracts to solutions, gels, or solid products used as dressings, as well as on nano-technological sensors to monitor the biochemical state of wounds. Due to their well-known anti-inflammatory and antioxidant effects, therapeutic dressings containing plant extracts are in fact showing an increasing trend in the treatment of chronic wounds. Although the previously mentioned qualities of essential oils were thoroughly examined, less effort was put into their used for wound healing.

Active dressings composed of plant extracts and polymers like hydrogels or hydrocolloids are being investigated as potential devices for the regulated release of analgesics, growth factors, antimicrobials, and anti-inflammatory medicines. In contrast to topical medicines in the form of liquids, creams, or ointments, which may be absorbed faster than necessary by the healing process, these polymeric matrices exhibit emergent features.[6]

History of Essential oils –

Essential oils used by people for thousands of years. These potent extracts were first used by the Egyptians around 4500 BC, who employed them for everything from cosmetics to mummification. In actuality, the Greeks, Romans, and Egyptians were among the first civilizations to use many of the most well-known essential oils, including lavender, peppermint, and eucalyptus. Essential oils were employed in massage and inhalation treatments in ancient Greece. Hippocrates, a renowned physician who lived from 460 to 377 BC, recommended a number of aromatic remedies, and his ideas are still widely followed today. Essential oils were also used by the Romans, especially in the bathhouse culture that was prevalent at the period. Aromatic baths and massages were thought to help the body unwind and regenerate.

Plants have played a significant role in Ayurvedic medicine in India for thousands of years. Among the herbal remedies used in traditional Chinese medicine are a number of essential oils.

The contemporary period of essential oils is credited to French chemist René-Maurice Gattefossé. Gattefossé was operating in a perfume factory when he accidently burned his palm. He was surprised to find that the agony quickly subsided and the cut completely healed without leaving any scars when he dipped his palm into a nearby vat of lavender oil. In his book Aromathérapie: Les Huiles Essentials Hormones Vegetables describes how this encounter motivated him to discover more about the medicinal benefits of essential oils.

Fig no. 2 – Image of Essential oils

Terpenes and Terpenoids used for wound healing

Terpenes that exhibit functional groups like alcohol, ketone, or aldehyde in their chemical makeup are known as terpenoids; examples include menthol, carvone, and neral. More membrane disruptions have been linked to terpenoids with -OH groups in their structure than to terpenoids with polar groups like limonene or those that accept hydrogen bonds like 1,8-cineole.

The systemic circulation, which reaches all target organs, can absorb EO chemicals because they are tiny, fat-soluble molecules that can pass through membranes, including the skin. Generally speaking, the cutaneous pathway and the respiratory tract provide the fastest routes of entrance. Aromatherapy essential oils (EOs) applied topically may irritate the skin, particularly if the oils are not diluted. Some oils, like bergamot oil, can also trigger malignant transformation and photosensitization.[7]

Because EOs are permeation enhancers, applying excessive amounts of highly concentrated oils to a sizable area of the skin or on broken skin can produce extensive systemic absorption and raise the risk of major side effects, such convulsions.[8]

Tea tree oil (from Melaleuca alternifolia) is the only oil that has been tried in chronic human wounds infected by Staphylococcus aureus methicillin-resistant (MRSA), a persistent issue in elderly patients, according to the antimicrobial activity displayed by several EO. In a particular randomized controlled experiment with nursing home residents, Lee and colleagues used 10% v/v of topical preparation. After 4 weeks of treatment, 14 out of 16 patients in the EO group had their infections totally cleared, and 16 out of 16 had their wounds closed; both results were significantly different from those of the control group.[9,10]

In the first report on monoterpenoids in wound healing, five studies employing purified borneol, -terpineol, and thymol, as well as genipin and aucubin, two monoterpenes derived from iridoids, were given. Similar instances were listed by Vyas and Vasconez (2014), who included a study using only pure limonene in a thorough review that also covered the most recent advancements in biological molecules—interestingly, all small terpenes/terpenoids—as well as developments in skin substitutes, bio membranes, and scaffolds. According to this study, monoterpenes' anti-inflammatory activities and wound healing have a strong relationship. Similarly, Barreto and colleagues include fibroblast growth effects, particularly for thymol, as well as antibacterial, antioxidant, low toxicity, and other properties in their work.[11]

Biopolymers for wound healing –

Biopolymers utilised for scaffolds and dressings include alginate, chitosan, collagen, and silk fibroin (proteins), as well as the polysaccharides chitosan and alginate. They are all derived from natural sources and have all been shown to have excellent to good biocompatibility and efficacy in the treatment of wounds. Numerous examples in the scientific literature demonstrate how these biomaterials can be functionalized with organic molecules to produce fresh approaches to various healing processes. In particular, an overview of the development of polymeric structures conjugated with medicinal plant extracts was presented in 2016 by Das and colleagues. However, the potential improvement of these biomaterials when paired with EO has just recently been investigated. So, in this section, we discuss instances when EO and polymers were coupled to promote wound healing. [12,13]

Even yet, it is important to note that other domains of application, such food packaging, have more experimental evidence about mixing EO with polymers. The effectiveness of these mixes depends on the EO's antioxidant and antibacterial characteristics, where chitosan has been heavily utilised. Lemongrass, rosemary, pepper, and basil essential oils have been successfully integrated into cellulose ester films for use in air freshener or food packaging applications.[14]

Collagen and gelatin

Experimental evidence supports the anti-inflammatory and antinociceptive properties of Lippia gracilis EO. Thymol is its primary constituent; thus, it was investigated for anti-inflammatory and wound-healing properties in mice using active collagen dressings. In order to create films, pure thymol was combined 10% in collagen (1% in 0.5 M acetic acid with 20% w/w of plasticizer). The dispersion was then cast and allowed to dry. A smaller wound area and better, denser collagen deposition were seen as a result of applying collagen-thymol dressings to wounds.

The anti-inflammatory and antinociceptive qualities of Lippia gracilis EO are supported by experimental data. Since thymol is its main component, its ability to reduce inflammation and speed up the healing of wounds in mice using active collagen dressings was examined. Pure thymol was mixed 10% in collagen (1% in 0.5 M acetic acid with 20% w/w of plasticizer) to make films. After that, the dispersion was cast and given time to dry. Applying collagen-thymol dressings to wounds led to a reduced wound area and better, denser collagen deposition. [15,16,17]

Chitosan

A chitosan hydrogel contained pure sesquiterpene nerolidol, which is widely present in essential oils such as neroli, jasmine, tea tree, and ginger. 2% and 4% of nerolidol were produced by adding 1 or 2 mL of pure nerolidol to 50 mL of chitosan 2% v/v dissolved in acetic acid, while stirring magnetically for 10 minutes. The pH was then raised to 4. In vitro testing of the antibacterial activity revealed that the two components worked together synergistically. Additionally, healing was examined in mice using circular excision wounds. Thyme essential oil (from Thymus vulgaris), which has antibacterial qualities, is another EO-chitosan combination for wound dressings (Altiok et al. 2010). Chitosan solution was made by dissolving 0.5 g of low molecular weight chitosan in 25 ml of 2% acetic acid; then, dropwise additions of 10% v/v ethanolic solution of EO were added to the chitosan solution to provide a range of final concentrations between 0.2 and 1.2% v/v. Solutions were poured onto polystyrene Petri dishes, vacuum dried for 24 hours at ambient temperature, and then dried again for 5 hours at 40 degrees. The mixture of polymer-EO and concentration 1.2% v/v demonstrated the highest antibacterial and antioxidant activity, as well as a minor increase in water vapour and oxygen transfer rates, both of which are advantageous properties for materials used in the treatment of wounds.[18]

Alginate

Eucalyptus globulus EO and alginate were coupled to generate nanofibers by wet spinning matrix in order to address the 1,8-cineole anti-inflammatory and antiseptic capabilities of 1,8-cineole and alginate fibers capacity for caring for moderate to highly oozing chronic and acute wounds (Khajavi et al. 2014). The loaded samples' increased antibacterial activity due to the EO content was confirmed. As a result, the combination of 1,8-cineole and alginate nanofibers was suggested as an appropriate one for occlusive or semi occlusive wound dressings.

In a recent experiment, ten different EO were independently mixed with alginate films to evaluate the films' antibacterial and antifungal capabilities. Hot water was used to dissolve sodium alginate (3% w/v), and after it cooled, glycerol (1% v/v) was added as a plasticizer. Immortelle, chamomile blue, cinnamon, lavender, tea tree, peppermint, eucalyptus, lemongrass, or lemon essential oils were added separately. The final solutions were cast and allowed to dry in ambient conditions after each EO was gradually blended into alginate/glycerol solutions and Igepal 1% was added as a surfactant. The concentrations utilised were 16%, 50%, and 66% of the dry weight of the film.

According to the EO type and concentration, films demonstrated stability under a range of humidity settings and inhibited the growth of bacteria and fungi. [19]

Due to their potential utility in the field of biomedicine, biodegradable polyesters have attracted a lot of attention. Since they provide a good barrier with precise mechanical properties, this class of polymers is especially appropriate for wound dressings. The ability of bio polyesters to be hydrolyzed in vivo by naturally occurring enzymes is another desirable quality. The macromolecular structure can also be adjusted to suit certain applications thanks to the backbone ester connections. To improve the physical qualities of the polymeric products, these biopolymers have already been combined with EO. In order to expand the possibilities of these bioplastics, the 40-carbon terpene -carotene, for example, was effectively blended with three distinct biodegradable polyesters: polylactic acid (PLA), poly--caprolactone (PCL), and poly (hydroxybutyrate-co-hydroxy valerate). Thermoplastic aliphatic polyester (PLA) is a bioactive material made from renewable resources like corn starch, tapioca roots, or sugarcane.[20]

Forthcoming polyesters

Table no. 1: Literature survey of essential oil which used for wound healing

Sr. No	Essential oil composition	Outcomes	Reference
1.	2% lavender oil	Increase rate of wound contraction. Reduction in inflammation Pain relief	[21]
2.	4% Lavandula aspic	Faster rate of wound contraction. Regeneration of epidermal layers more closely natural skin structure	[22]
3.	Cream containing lavender oil, beeswax, D-panthenol, glycerin, vitamin E, allantoin, and dimethicone	Faster rate of wound contraction shorter epithelialization period	[23]
4.	L. angustifolia oil	Increased expression of EGF	[24]
5.	Lavandula x allardii honey and oil	Reduction in capillary volume by honey	[25]
6.	Lavender-thymol oil	Reduction in REEDA	[26]
7.	Clove oil	Enhanced wound healing activity	[27]
8.	Eucalyptus oil	Enhanced wound healing activity	[28]
9.	Marigold oil	Enhanced wound healing activity	[29]
10.	Tea tree oil	Enhanced wound healing activity	[30]

CONCLUSION

Current review suggests that topical application of lavender essential oil may have therapeutic benefits for wound healing through mechanisms like accelerated wound contraction, increased activity of the proteins involved in tissue remodelling, and elevated collagen expression. Additionally, it was discovered that using different essential oil (lavender, tea tree, eucalyptus, marigold and clove oil) to episiotomy sites decreased both pain and REEDA ratings.

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Authors Contribution –

The review paper was combined the efforts and contributions of all authors.

Conflict of Interest –
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