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Promising Medicinal Plants and their Potential Active Constituents for Healing of Superficial Burn Wounds- A Review

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Abstract

Burn injuries represent a diverse and varied challenge to medical and paramedical staff. Correct management requires a skilled multidisciplinary approach that addresses all the problems facing a burn patient. The burn injury represents an assault on all aspects of the patient, from the physical to the psychological. It affects all ages, from babies to elder people, and is a problem in both the developed and developing world. This review aimed to summarize knowledge on the possible use of selected medicinal plants expected to treat superficial burns on basis of their promising active ingredients, achieving the treatment goals. Superficial and partial-thickness burns are the most common in pharmaceutical practice. The ideal natural treatment of such type of burn injuries that we would like to recommend should, in addition to healing properties, has the following properties: infection prevention, reducing wound inflammation, non-toxic, biocompatible and cost effective, so as to avoid progress of the superficial burn wounds into deeper ones and preventing serious local and general complications.

Medicinal plant extracts can compete with conventional burn treatments and potentially promote the treatment of burn wounds due to their diverse mechanism of action, antimicrobial activity, antiinflammatory effects, the safety of use and the cost effectiveness. The growing interest in alternative medicine encourages phytochemical and biological investigations of plant extractives expected to promote healing of superficial burn wounds, taking into accounts the use of not only single preparations but also their mixtures and Nano-formulations; as the research conducted so far often suggest a synergistic effect and Nano-formulations of the phytochemical ingredients such as **volatile oils**, **sterols** and **flavonoids**.

Keywords: Burns; superficial burns; burn injuries; burn wounds; medicinal plants; plant extracts.

1. Introduction

Most of us have experienced the severe pain that can result from a minor burn. However, the distress and pain induced by a severe burn extend beyond the immediate incident. The invisible psychological and the visible physical scars are long lasting and often cause chronic organ dysfunction [1].

Both medical and paramedical staff encounters an extensive and wide variety of challenges when treating burn injuries. Proper management of a burn patient requires an expert multidisciplinary approach that addresses every challenge encountered.

Severe burn injuries caused by accidents can have devastating consequences for the victim. The recovery process for burn victims may involve multiple surgical procedures, prolonged hospitalization, and extended physical therapy, depending on the severity of the burn. Furthermore, burn injuries may affect the victim and their family economically, socially, and psychologically, resulting in severe consequences such as social stigma and limited social participation. So those who have suffered severe burn injuries should seek the highest quality of medical care [2].

Burns result in the invasion of deeper tissues of the skin or body by microbes. To effectively treat burn wounds, topical preparations should ideally possess antibiotic properties and facilitate the healing process [3].

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Since the 1960s, silver compounds have formed the basis of conventional topical burn treatments. It has developed into a benchmark by which non-silver therapies are assessed over an extended duration of time. Silver compounds possess a significant advantage in that they are lethal to a broad spectrum of microbes, including fungi, but most chemical substances reduce the healing process.

Conversely, bioactive or naturally occurring substances extracted from various plant materials are safer and have fewer adverse effects; thus seem to be among the limited number of commercially available alternatives utilized in burn treatment. It is widely believed that a number of natural substances, including honey and moist exposed burn ointment (MEBO®), can effectively promote wound healing and infection protection without inducing the detrimental side effects associated with purified chemicals. (MEBO)®, a natural oil-based preparation with Chinese origins, finds widespread application in Asia and the Middle East. It is composed of beta-sitosterol, a plant steroid and berberine oil that alleviates pain, retains moisture and soothes wounds. Beta-sitosterol stimulates epithelialization [3].

It is impossible to overstate the potential significance of naturally occurring compounds in the treatment of a variety of human diseases. So there is a now-strong recommendation for bio-prospecting and investigating naturally occurring products that may offer protection and treatment against specific diseases [4].

Certain plant materials were selected to be used as natural source of various natural products and phytochemical constituents; including volatile oils, sterols, triterpenes, poly-phenolic compounds and other constituents (Fig. 2).

2. Description, etiology, classification, pathophysiology and complications of burns

The largest organ of the body is the skin (integumentary system) covers an average of 1.5-2.0 square meters in an adult [5]. It consists of dermis, epidermis and subcutaneous fat or hypodermis. It provides multiple functions, such as regulating temperature, preventing fluid loss, and acting as an infection barrier (Fig.1).

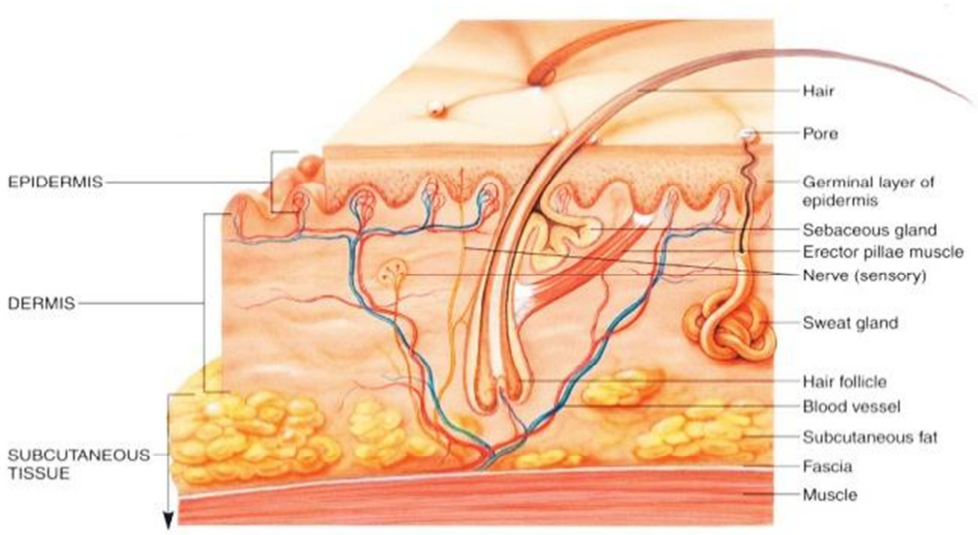

Figure 1: Anatomy of human skin.

Burns occur when living tissue is exposed to thermal, chemical, or electrical energy, resulting in damaging effects on the epithelium and underlying tissues. Thermal burns can be caused by a variety of external heat sources (flames, hot liquids, hot solid objects, or steam) [6].

Burns are categorized according to the percentage of total body surface area (TBSA) affected and their depth to (1st-degree, superficial and deep partial-thickness, and full-thickness). Patients getting significant burns (>20% TBSA) must have fluids resuscitated. Treatments of burn wounds include topical antibacterial, regular cleaning, raising of the affected limb, and sometimes skin grafting [7].

Coagulation necrosis results from the denaturation of proteins caused by burns. Around the coagulated tissue, platelets aggregate, vessels constrict, and marginally perfused tissue (known as the zone of stasis) can extend around the injury. Tissue within the zone of stasis is inflamed and hyperemic [5].

External fluid loss and bacterial invasion occur when the normal epidermal barrier is damaged. Additionally, edema often develops in the affected tissues, which contributes to the loss in volume. Due to the absence of thermal regulation of the damaged dermis, heat loss can be significant especially in exposed wounds [6].

Burns cause both local and systemic complications. Local complications of burns include eschars, scarring, contractures, keloids and dyspigmentations in the form of either hypopigmentations or hyperpigmentations. Principal contributors to

systemic complications include damaged skin integrity which induces infection and fluid loss leading to hypovolemia and metabolic abnormalities [8, 9].

A- Local Complications

- Eschar is dead, rigid tissue that has been deeply burned. An eschar that completely encircles a limb in a circumferential direction (or sometimes the torso) is potentially constricting. In response to edema, a constricting eschar restricts tissue expansion; instead, tissue pressure rises, ultimately resulting in local ischemia. Respiration can be hindered by an eschar that encircles the thorax, whereas ischemia endangers the functionality of the limbs and digits.

- Scarring and contractures arise because of deep burn healing. Contracture deformities at the joints can appear depending on the scar's extent. Critical impairment of function may result from burns situated near joints, especially in the hands, feet, or perineum. Scarring may be increased by infection.

- Keloid is a keratin accumulation that can develop in burn patients, particularly those with darker skin tones.

- Hyper-pigmentation is the resultant increase in melanin concentration following to improper or unhealthy healing of the skin.

- Hypo-pigmentation is the resultant decrease in melanin concentration following to improper or unhealthy healing of the skin.

B- Systemic (general) Complications:

Systemic complications of burns include infection, hypovolemia and metabolic abnormalities.

3. Depth of burns

The depth of burns is affected by many factors; the most crucial are the intensity of energy source, duration of exposure and type of injured tissue.

Burns can develop and are not static. Within a few hours, a first-degree burn may progress to a second-degree burn by affecting deeper structures. Consider sunburn followed by blisters the following day. In the same way, burns of the second degree may progress to third degree burns. [10].

Regardless of the burn type, inflammation and fluid accumulation in and around the wound occur. Furthermore, it is important to mention that the skin serves as the primary barrier of the body against microbial infections. An infection may potentially spread from the site of the injury to other areas of the body, as a burn indicates a perforation in the skin.

The capacity for self-regeneration is exclusive to the epidermis. Burns with a greater depth have the potential to induce irreversible harm and scarring, impeding the restoration of normal skin function in the affected area [10].

4. Signs and symptoms of burns

Burns signs and symptoms depend on the burn depth [5, 11];

4.1. First degree burns (Superficial burns); e.g. sun burns.

These burns cause damage to the epidermis. They are painful and tender, red, locally inflamed, and blanch significantly and extensively in response to light pressure. Bullae or vesicles might not develop.

4.2. Second degree burns; which is either;

- Superficial partial-thickness burns; e.g. scald burns.

These burns cause damage to the epidermis and various degrees of the dermis. They blanch in response to pressure and are tender and painful. One day later, vesicles or bullae form. Following the formation of a fibrinous exudate, the bases of vesicles and bullae become pink.

- Deep partial-thickness burns; e.g. chemical burns.

In these burns, damage occurs to both the epidermis and the deeper layers of the dermis. They can be white, red, or red with mottling. They are less painful and tender than burns that are more superficial and do not blanch. The characterization of a pinprick as pressure rather than as sharpness is common. Vesicles or bullae may form; these burns are typically dry in nature.

4.3. Third degree burns (Full-thickness burns); e.g. flame burns.

These burns cause damage to all skin layers. Due to the presence of fixed haemoglobin (Hb) in the subdermal region, these can take on color such as bright red, brown and leathery, white and malleable, or black and charred. Full thickness burns are painless due to destruction of the nerve endings and the blood vessels, except in surrounding tissues with partial thickness burns [10].

5. First aid of burns

Smouldering and hot material is extracted while the ongoing fire is extinguished. Each cloth item is removed. Water flushes all chemicals, except powders; Brushing away powders prior to wetting is recommended. Burns induced by organic compounds, acids, or alkalis (e.g., petrochemicals, cresols, phenols) are rinsed with copious quantities of water for a minimum duration of 20 minutes, or until no trace of the initial solution remains.

Following wound cleansing and evaluation by the final treatment provider, burns may be treated topically. In the case of superficial partial-thickness burns, topical treatment is typically sufficient, while deep partial thickness burns might necessitate skin grafting and early excision. Full-thickness and deep partial-thickness burns alike should ultimately be treated via excision and grafting, but topical treatments containing agents with potent healing properties are suitable in the interim [12].

6. Treatment strategy

Burn treatment is dependent on the burn's depth, area, and location. To promote healthy healing and minimize or eliminate complications, initial treatment agents for superficial burns must possess each of the subsequent properties; Antimicrobial property, anti-inflammatory property, anti-oxidant property and pain relieving power (analgesia) [13, 14, 15].

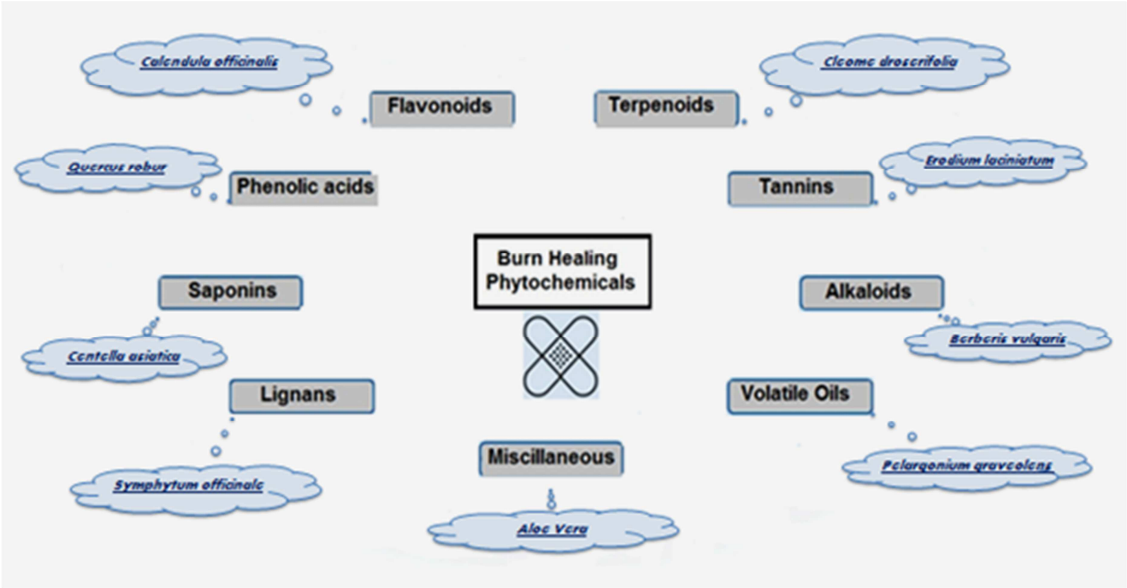

Figure 2: Examples on phytochemical constituents expected to promote healing of superficial burn wounds.

7. Herbal remedies for superficial burn treatment

The potential therapeutic effects of medicinal plants believed to improve superficial burns healing are described in this section, to ascertain the possibility of their usage for burn treatment based on their promising phytochemical constituents. Many of these plants had been traditionally used for treating dermatological disorders, as well as infectious diseases.

The following medicinal plants could be used for superficial burn wound treatment;

- ***Erodium laciniatum* (Cav.) Willd**; also known as 'cutleaf stork's bill'; family **Geraniaceae.**

  The aerial parts of this plant contain flavonoids, tannins and other phenolic constituents which may give rise to successful burn treatment, owning to their antimicrobial, antioxidant and anti-inflammatory characteristics [16].

  Regarding the relationship between scientific evidence and traditional use, further investigation of the Erodium genus requires major efforts [17,18].

- ***Pelargonium graveolens* (L'Hér.) Thunb.**; also known as 'sweet scented geranium'; family **Geraniaceae.**

  The leaves of this plant are rich in volatile oils constituents like citronellol, nerol and geraniol. The plant has been traditionally used to treat abrasions, burns specially; sun burn, in addition to fungus infections [19].

  Biological investigations about this plant revealed that it was effective as a skin tonic and vulnerary agent, due to its antimicrobial and anti-inflammatory effects [20].

- ***Aloe Vera* L.**; also known as 'aloes'; family **Liliaceae.**

  The fresh aloes gel contains mucilage (hetero-polysaccharide) that helps to promote skin healing by antimicrobial & immune-stimulating actions. In addition to other carbohydrates which include glucomannan & acemannon. Aloes also contains lipids like cholesterol, gamolenic acid, & arachidonic acid. Other phytochemicals are vitamins (Vit.C & Vit.E.) and zinc mineral [21].

  Aloes is traditionally used to assist healing of wounds, burns, eczema, & psoriasis. The fresh leaf gel of this plant; soothes pain, cools the skin and stimulate blood flow to burns, sunburns, red painful skin and blisters [21].

Aloe gel may be used itself or incorporated into many creams, ointments, & lotions to be applied on the affected area of skin [22,23].

- ***Althaea officinalis* L.**; also known as 'marsh-mallow'; family **Malvaceae.**

The roots (primarily), the leaves and flowers (to a lesser extent) are commonly used for their mucilage (polysaccharides) contents which reached 5-11.6 % (depending on vegetative period). Other carbohydrates are; starch 25-35%, pectins 11%, mono-, di-saccharides saccharose 10%. Other phytochemical constituents include flavonoids like isoquercitrin, caffeic, kaempferol, hypolaetin-8-glucoside, p-coumaric acid, ferulic acid, p-hydroxybenzoic acid, salicylic acid, p-hydroxyphenylacetic aicd, vanillic acid, coumarins and scopoletin. The plant also contains phytosterols, tannins, in addition to amino acids like asparagine.

Traditionally, the plant has been used in the therapeutic management of several inflammatory disorders like sore throat, cystitis and sun burns. The biological trials reported that the plant is used for its soothing effects as a demulcent, also for its antimicrobial and anti-inflammatory effects, in addition to its immune-modulatory activity [24].

- ***Berberis vulgaris* L.**; known as 'Common barberry'; family **Berberidaceae.**

In addition to the fruits, the stem bark, stem root, and root bark contain a substantial quantity of phytochemical substances including vitamin K, ascorbic acid, various triterpenoids, over 10 phenolic compounds, and over 30 alkaloids.

Historically, the plant has been employed in the treatment of eye, ear, and mouth infections, aid in weight loss, and promote rapid wound healing, to cure piles and haemorrhoids, to treat dysentery, indigestion, uterine and vaginal disorders additionally as an antidote for snake or scorpion bites. It is utilized orally and topically in Iranian traditional medicine to treat jaundice, enlarged liver, enlarged spleen, eye sores, toothache, asthma, and skin pigmentation, to dry unhealthy ulcers, and to eliminate inflammation and swelling [25].

Biological investigations of the common barberry revealed its antimicrobial, anti-inflammatory, antioxidant and analgesic properties [26].

- ***Calendula officinalis* L.**; known as 'Ruddles' or 'Common Marigold'; family **Compositae.**

The golden orange or yellow flowers are rich in flavonoids, high molecular weight polysaccharides, triterpenes, volatile oils, carotenoids and saponins.

This plant is used traditionally in various dermatological conditions to promote wounds healing, burns (minor, including sunburn), eczema, and poorly healing sores [27].

Researchers had been reported many biological activities like superficial burn healing activity (due to the antimicrobial, anti-inflammatory, anti-edematous and antioxidants effects) and immune-stimulant activity (due to the polysaccharide content) [28, 29].

- ***Carum carvi* L.**; known as 'wild caraway'; family **Umbelliferae**.

This plant contains 1–9% essential oils, flavonoid constituents; include quercetin-3-glucuronides, isoquercitrin, quercetin-3-O-caffeylglucoside, and kaempferol 3-glucoside. In addition to protein, lipids (fat), carbohydrates, fibers, iron, calcium, phosphorus, magnesium, zinc, sodium, potassium, ascorbic acid, riboflavin, thiamine, niacin, vitamin B_6, folate, vitamin A, vitamin E, saturated and unsaturated fatty acids.

Traditional uses include gastrointestinal troubles; abdominal cramps, sensations of fullness, nervous cardiac-gastric complaints, spasmodic gastrointestinal complaints, infant flatulent colic relief, irritable stomach, indigestion, loss of appetite, and dyspepsia. Additionally, it was used as a diuretic, tranquilizer, emmenagogue, gastric stimulant, astringent, aphrodisiac, to enhance liver function, as an analgesic and to treat bronchopulmonary conditions and cough. [30].

Biological trials were made to prove the antibacterial, antifungal, antioxidant and analgesic effects, in addition to its potential for the treatment of first degree burns (due to its essential oil content) [31].

- ***Centella asiatica* L.**; known as 'Gotu Kola' or tiger herb; family **Umbelliferae**.

The nickname "Tiger herb" because injured tigers often rub against it, to heal their wounds.

The leaves and roots of this plant contain triterpenoidal saponines; asiaticoside, asiatic acid, & other triterpenoidal saponines.

It has been traditionally used to treat wounds, abrasions, cuts, burns; sunburn and eczema. It is also used to reduce cellulite formation [32].

Reported biological trials include the investigation of the excellent vasodilator effect and blood vessel strengthening power of the herb. In addition to the anti-inflammatory and neuroprotective effects the collagen stimulating activity related to asciatic acid content [33].

- ***Cleome droserifolia* (Forssk.) Del.**; known as 'Samwah'[Arabic]; family **Cleomaceae.**

The aerial parts especially leaves of this plant contain methoxylated flavonoids, volatile oils, glucosinolates, sterols and triterpenes.

Folk medicine generally uses *Cleome species* as rubefacients, stomachics, and to treat rheumatic fever, inflammation, and scabies. Herbalists in Egypt use the dried herb as a hypoglycemic agent, and the Bedouins residing in the southern Sinai region extensively use its decoction for the management of diabetes [34].

The herb was biologically investigated for its healing power for burn wounds due to its promising antimicrobial activity against wide range of microbes viz. *Streptococcus viridens*, *Staphylococcus aureus*, *Pseudomonas aeruginosa, & Bacillus*

subtilis which commonly invade burn wounds. Moreover, it has anti-inflammatory characteristic, as well as, its antioxidant, anti-edematous and immune-modulatory effects [27].

- ***Echinacea angustfolia* DC.**; also known as 'purple coneflower'; family **Compositae.**

  The aerial parts especially flowers contain glycosides (echinacosides), polysaccharides, alkamides, and flavonoids.

  Traditional uses include internal use to treat stomach cramps, coughs, pain and snake bites; external use to treat wounds, burns, and insect bites; and chewing roots to alleviate toothache and throat infections. [35].

  Biological investigations revealed the pronouncing antimicrobial activity **(**alternative to topical antibiotics**),** also the immunostimulant, anti-inflammatory and antioxidant effects had been investigated [36].

- ***Eucalyptus globulus* Labill.**; also known as 'blue gum eucalyptus'; family **Myrtaceae**.

  The leaves oil of the plant contains 1.8 cineole (eucalyptol) (44.3%), camphene (23.1%), Bpinene (12.7%), α-pinene (9.5%), Globulol (7.3%), Limonene (5.1%) [37].

  It has been traditionally used as a remedy for abrasions, cuts, burns, sunburn, skin ailments, respiratory tract disorders, arthritis, & diabetes.

  The potent antiseptic effect, anti-inflammatory and analgesic properties had been biologically investigated [37].

- ***Hamamelis virginiana* L.**; Known as 'witch-hazel'; family **Hamamelidaceae.**

  The leaves and barks contain volatile oils as the main active constituent; they also contain tannins (Gallo-tannins), polymeric proanthocyanidins and polysaccharides. [38].

  The aromatic oil extracted from the bark had been used to treat skin inflammations such as abrasions, burns, scalds, and insect bites [39].

  Nowadays, it is an essential component in formulations for natural skin care and anti-aging products used for all types of skin. It is approved in the United States, as an over-the-counter drug for its analgesic and anti-itching properties. Also it is approved in Germany for the treatment of burns, dermatitis, piles, skin injuries, and varicose veins [40].

- ***Hypericum perforatum* L.**; also known as 'St. John's wort'; family **Hypericaceae.**

  Oil of the above ground (aerial) parts of the plant; herb tops and flowers contain dianthrones; hypericin, flavonoids, xanthrones and hyperforin.

  It has been traditionally used for the treatment of depression, also used for burns and wounds treatment [41].

  The plant has a vulnerary action; be used to disinfect and heal wounds. It is effective as a compress for dressing wounds and the oil is soothing for burns, since it lowers the temperature of the skin. Often useful when the pain of a burn is intense and the nerves are extremely sensitive [42].

- ***Lavandula officinalis* Chaix**; known as 'English lavender'; family **Lamiaceae.**

  Essential oil is derived from freshly harvested flowers and contain the principal components; linalool (30.6%), linalyl acetate (14.2%), geraniol (5.3 %), β-caryophyllene (4.7%), lavandulyl acetate (4.4%).

  Lavender flower teas, pillows, and baths have traditionally been used primarily as a mild sedative. Flower oil has the capacity to alleviate specific nerve-related disorders, including mild insomnia. Lavender preparations also used for their carminative, stomachic, diuretic, and spasmolytic actions. Lavender is used in aromatherapy to treat a wide range of skin conditions, such as burned areas, insect bites, inflammation, and minor cuts [43].

  It is believed that the antiseptic and anti-inflammatory properties of lavender oil could aid in the healing of minor burns and insect bites. Improvement of wound healing is primarily attributed to the stimulation of growth factors in the epidermis and dermis, as opposed to alternative topical applications [44].

- ***Matricaria chamomilla* L.**; known as 'German chamomile'; family **Asteraceae**.

  The flowers oil, leaves and stems contain essential oil include; the sesquiterpenes α-bisabolol, farnesene, and chamazulene; the blue essential oil; (0.2 to 1.9%) which finds a variety of uses. Other important constituents are sesquiterpenes, flavonoids, coumarins, and polyacetylenes. [45].

  The herb is traditionally used for its antiseptic and anti-inflammatory properties, as well as its antispasmodic and mild sudorific effects. The powdered form of the medication can be applied topically to cure slow-healing wounds, skin eruptions, and infections such as boils and shingles. Additionally, it can be utilized to treat inflammation of the mouth, eyes, throat and haemorrhoids.

  Second-degree superficial burns might be treated with chamomile cream as a natural alternative remedy [46].

- ***Melaleuca alternifolia* (Maiden & Betche) Cheel.**; known as '*tea tree'*; family **Myrtaceae**.

  Tea tree oil is rich by terpenoids mainly terpen-4-ol, which make up at least 30% & preferably 40-50% of the oil to be medicinally useful. It has 11 times the potency of phenol, which was among the most potent antiseptics in commercial use at the time. Another compound cineole should make up less than 15% and preferably 2.5% of the oil.

  Tea tree leaves were used to treat cuts & skin infections. Tea tree oil at strength of 70-80% should be topically applied moderately at least twice per day to the affected areas of skin [47].

  The oil kills fungus and bacteria, including those resistant to some antibiotics. It also has analgesic, antiseptic, antiviral activities. It is used for its vulnerary and immune stimulating activities, as well [48].

Due to the natural antiseptic properties of tea tree oil, it is an ideal natural remedy for superficial skin burns. The oil readily absorbs due to its non-greasy composition, facilitating natural healing and breathing of the skin [49].

- ***Melissa officinalis* L.**; known as 'lemon balm' or 'sweet balm'; family **Lamiaceae.**

The Leaves and leaves oil contain essential oil which includes monoterpenoid aldehydes (including neral, geranial and citronellal), poly-phenolic and flavonoids compounds such as monoterpene glycosides and rosmarinic acid.

Traditionally, the leaves have been recommended for consumption as an herbal tea or for external use in the form of an essential oil, for the treatment of gastrointestinal tract disorders, nervous system, liver, and bile [50].

Antioxidant, antimicrobial, and antifungal properties of the plant were investigated in relation to the healing of second-degree burn wounds and oxidative stress in the serum of patients with burn injuries [51, 52].

- ***Oenothera biennis* L**; known as '*Evening Primrose'*; family **Onagraceae.**

The roots, leaves, blossoms, flower buds and the seed oil are rich in moisturizing and nourishing fatty acids. The plant is a very rich source of linoleic acid (66-76%), and also contains the soothing and healing superstar fatty acid, gamma-linolenic acid (GLA, 7-12%) along with other phenolic constituents.

Evening primrose oil (EPO) has been a widely recognized dietary supplement since the 1980s. It appears to be beneficial for a variety of conditions, including acne, dry eyes, brittle nails and sunburns [53].

EPO prevents the loss of moisture, maintains the skin's elasticity, and retards the aging process. The healing properties of linoleic acid extend to burns and scars, as well as scaly, inflamed, and rough skin associated with atopic dermatitis [54].

- ***Plantago lanceolata* L.**; also known as 'English plantain'; family **Plantaginaceae.**

The plant leaves contain phenyl ethanoids such as cistanoside F, acteoside (verbascoside), plantamajoside, lavandulifolioside and isoacteoside. The plant is inedible to some herbivores due to its content of iridoid glycosides aucubin and catalpol.

The leaves had been applied topically (fresh leaves) or internally (as syrup or tea) to treat skin disorders, insect bites, infections, and respiratory tract disorders [55, 56].

The flower extract enhances wound healing in rats due to its antimicrobial and anti-inflammatory properties, which aid in the wound healing at a faster rate [57, 58].

- ***Quercus robur* L.**; also known as 'English oak'; family **Fagaceae**.

The bark of the plant mostly contains tannins (ellagitannin), gallic acid and other phenolics and triterpenoidal substances.

It has been used as a styptic; (astringent). Externally an alcoholic tincture or cream helps fight *Staphylococcus* infection, and a cold compress is good for burns & cuts [59].

Biological investigations for the antimicrobial, anti-inflammatory and antioxidant effects had been reported [60].

- ***Symphytum officinale* L.**; known as 'common comfrey'; family **Boraginaceae**.

The leaves and roots contain allantoin and mucilage, which are regarded as the primary components of comfrey responsible for the anti-inflammatory and herbs soothing effects.

Historically, comfrey has been utilized topically for the treatment of numerous conditions, such as ulcers, thrombophlebitis, sprains and strains, as well as wounds. Topically, comfrey was also used to treat minor skin irritations and inflammation [61].

The application of an ointment containing comfrey extract resulted in a significantly shorter wound healing time compared to the use of comparable preparations. The difference was statistically significant regarding the ointment base free of active ingredients. [62].

- ***Tilia platyphyllos***; known as 'large leaf linden'; family **Malvaceae.**

The plant leaves contain terpenoid, kaempferol, p-coumaric acid and quercetin constituents, as well as volatile oils; including limonene, eugenol, citral, citronellal and citronellol. The major components of volatile oil are β-caryophyllene (26%), trans-dihydrocarvone (18%), cis-dihydrocarvone (11%), limonene (12.9%) and carvone (6%). The plant also contains tannins that can act as an astringent [63].

Historiographically, *Tilia platyphyllos* has been used to treat anxiety-related health issues and to calm nerves. Ingestion of charcoal derived from the plant's wood to treat intestinal disorders; topical application to address edema or infections.

Several biological trials to investigate the antimicrobial, anti-inflammatory and antioxidant activities had been reported [64].

- ***Ulmus fulva* Michx.**; known as 'Slippery elm'; family **Ulmaceae.**

The inner bark of the plant contains high amount of mucilage. It is recommended that 10 years old bark be used & the powdered bark should be grey of fawn-colored (not dark or reddish) otherwise, good results will not be obtained.

The plant's bark has been traditionally used to cure abrasions, cuts, burns; sunburn, sore throat and diarrhea. Bark powder is regarded as a potential poultice for minor burns, boils, ulcers, wounds, and the reduction of pain and inflammation. [65].

Biological investigation reported the demulcent effect of the plant; soothes and protects irritated or inflamed tissue. It is also used as emollient; when applied topically [66].

- ***Urtica urens* L.**; also known as 'burning nettle'; family **Urticaceae.**

Leaves of this plant could be considered as a source of sterols (mainly β-sitosterol), stigmasterol, campesterol and ergosterol [67].

The whole plant has been traditionally used for the treatment of uric acid diathesis, gout, joint pain, lithiasis, urticaria, agalactia and burns; mostly used in first degree burns confined to superficial skin. *Urtica Urens* is recommended for burns characterized by stinging, itching, or prickling, and is considered one of the top homeopathic medicines for the treatment of first degree burns [67].

The anti-inflammatory and antioxidant effects of the plant had been biologically investigated [68].

8. Conclusions

The pronounced biological activities of medicinal plants could be achieved by extracting the plant material with solvents of varying polarities as the promising bioactive ingredients are resident in both polar and non-polar plant extractives. The incorporation of the phytochemical constituents prepared as single and combined recipes in the form of topical pharmaceutical dosage forms like ointments and gels may be of great value for enhancing healing of superficial burn wounds [69].

Biological results proved the bioactive use of these plant extractives containing non polar compounds (e.g. petroleum ether extractives); containing unsaponifiable and saponifiable plant constituents. In addition to the plant extractives containing polar compounds (e.g. alcohol extractives), which have promising biological activity [70].

9. Recommendations

The reported biological activities of the selected medicinal plants recommend the use of combination of the plant materials under investigation [71], to be incorporated and formulated in the form of nanoparticles topical pharmaceutical formulations for the treatment of superficial burn wounds, so as to synergize action, provide effective drug delivery system, minimize dose and enhance their healing power for the treatment of burn wounds [72].

10. Conflicts of interest

"There are no conflicts to declare".

11. Acknowledgments

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