

HERBAL ACTIVES

compounds of the terpene groups

a closer look at the active diterpenes,
triterpenes, and tetraterpenes.

Lesson #5

Elder flower

Violet leaf

Dandelion flower

St John's wort

Hops flower

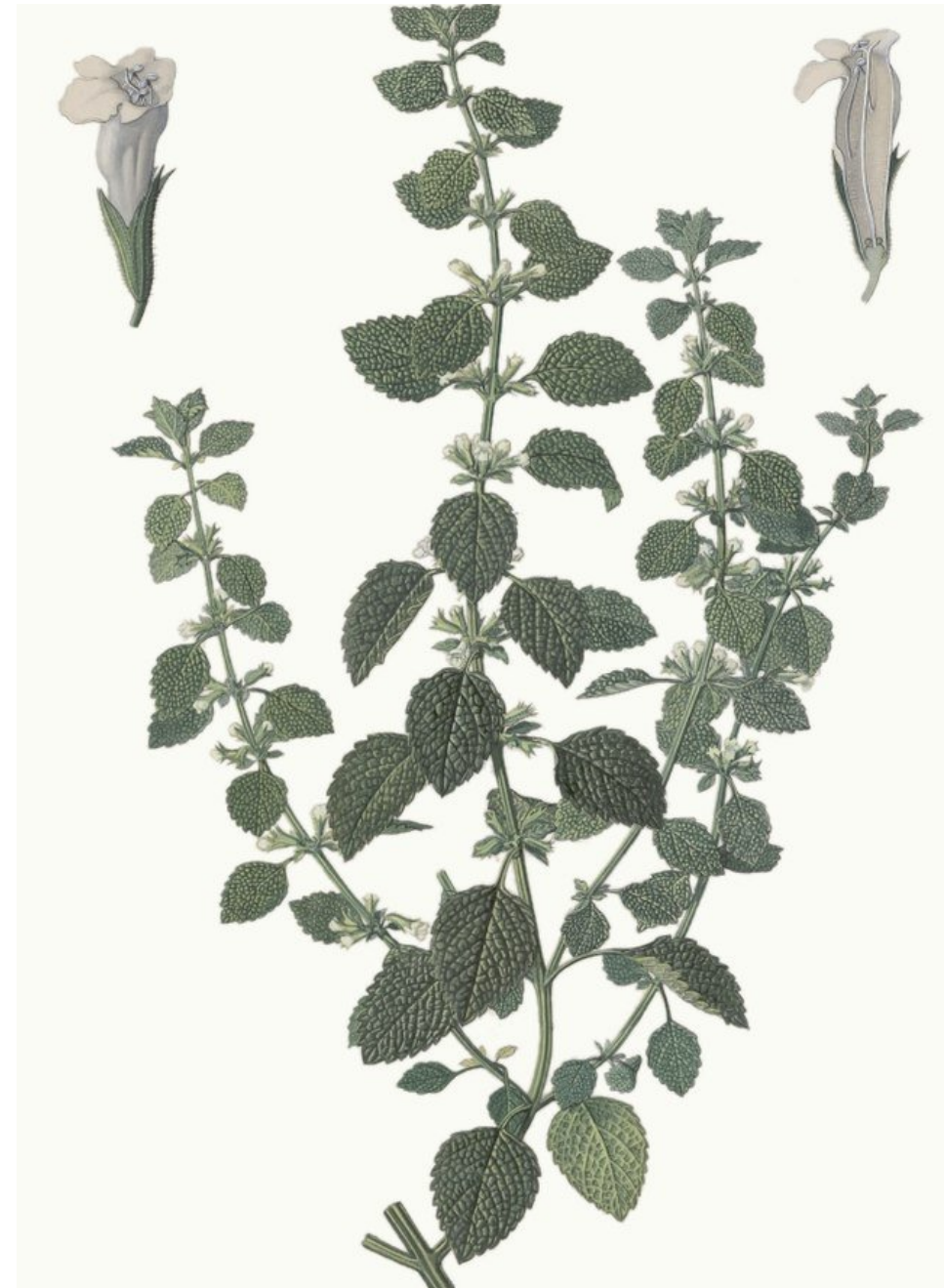
triterpenes

This lesson aims to take a deeper look at the most common compounds of the terpene group found to stimulate the healing of the skin from the plants.

The terpene group, as we saw in the previous lesson, is large with multiple members from the di-, tri-, and tetra-terpene groups, playing a significant role in available plant constituents.

The next slide is a detailed chart of the isoprenoid group of plant compounds that includes the individual compounds that appear in many of the healing herbs.

drawing of lemon balm



Terpenes & Terpenoids

- Both terpenes (CH) and terpenoids (CH+O₂) are present in ALL parts of the plant.
- Built from repeating isoprene units consisting of five hydrocarbons (C₅H₈).
- Terpenes can be highly aromatic, the smaller volatile ones making up the essential oils while larger ones are found in the fixed oils.

Small volatile compounds:

Isoprene unit	1 isoprene unit	5 carbon atoms	basic unit 5C - (C ₅ H ₈)
Monoterpenes	2 isoprene units	10 carbon atoms	essential oils, limonene, geraniol, thymoquinone, pinene, myrcene, linalool, camphene,
Sesquiterpenes	3 isoprene units	15 carbon atoms	essential oils, farnesol, bisabolol, caryophyllene, cedrene, zingiberene, farnesene

Larger non-volatile compounds:

Diterpenes **4 isoprene units** **20 carbon atoms** (neutral color) Resins, Retinol (vitamin A₁), Retinal, Retinoic acid, Retinyl esters, Carnosic acid, Pine resin, Abietic acid, Phytol, Cafestol, Kahweol, Taxodione

Triterpenes **6 isoprene units** **30 carbon atoms** (clear, waxy, or white) **Squalene**, Ursolic acid, Oleanolic acid, Betulin, Betulinic acid, Asiaticoside, Faradiol esters, Madecassoside, α & β-Amyrin, Taraxasterol, Shottenol, Spinasterol, Cycloartenol, Lupeol, Saponins, **Phytosterols**: Stigmasterol, β-Sitosterol, Campesterol, Brassicasterol, Δ⁵-Avenasterol, Δ⁷-Stigmastenol

Tetraterpenes **8 isoprene units** **40 carbon atoms** (brightly pigmented, red, orange) **Carotenoids**, β-Carotene, Lutein, Lycopene, Astaxanthin, (pro-vitamin A) Tocotrienols, Abscissic acid (ABA), Strigolactones, Bixin and Norbixin, Crocetin, Corcins

diterpenes

For the skin, diterpenes offer several benefits, especially in reducing inflammation, antioxidant activity, and promoting collagen production.

Many diterpenes also help modulate skin hydration and provide antimicrobial properties, making them valuable for treating conditions like acne, dermatitis, and skin aging.

Diterpene compounds are prominent in infused oils like rosemary, sage, and carrot seed oil, where they contribute significantly to their therapeutic actions.



triterpenes, squalene

Squalene is a well-known triterpene; see the separate lesson that focuses on the primacy of the squalene molecule.

Squalene, the biological precursor of all triterpenes, which in turn leads to the production of steroids and sterols, is a primary molecule of life.

Most triterpenes are solid, waxy, or resinous; however, squalene is unique: it's a liquid hydrocarbon triterpene and a natural component of human sebum, making it especially compatible with the skin.

Amaranth seed oil



triterpenes

Triterpenes, as a class, regenerate tissue, modulate the immune system, and maintain cellular structures.

Triterpenes are also, for the most part, lipophilic, so oil-soluble with a few exceptions.

They play a direct role in collagen support, rebuilding lipid structures in the skin, and controlling damaging inflammation.

Triterpenes are neutral or pale in color and can affect the texture and feel of some oils and butters.

A few triterpenes occur commonly in the herbs used for infusing plants in oils.

We will cover the most common triterpenes that occur in many of the herbs we use to infuse into the oils.



triterpenes

The mechanisms the triterpenes use to heal the body are both:

Physical, they form protective films

Biochemical, they are able to modify signaling pathways

Their diversity means that some specialize in wound healing while others are more antioxidant or antimicrobial, but even with different strengths of action, they often overlap in function.

In addition, they modulate lipid production and support ceramide synthesis a primary part of the protective stratum corneum, the skin's barrier function.

This can enhance the barrier function considerably, maintaining hydration in the stratum corneum.



Triterpenoids like ursolic acid, β -amyrin, lupeol, and taraxasterol found in comfrey leaf don't just "act on" the skin passively.

We will cover each of these compounds and the plants in due time.

Instead, they are bioactive signaling compounds, agents in the communication between skin layers and functions, and the rest of the body.

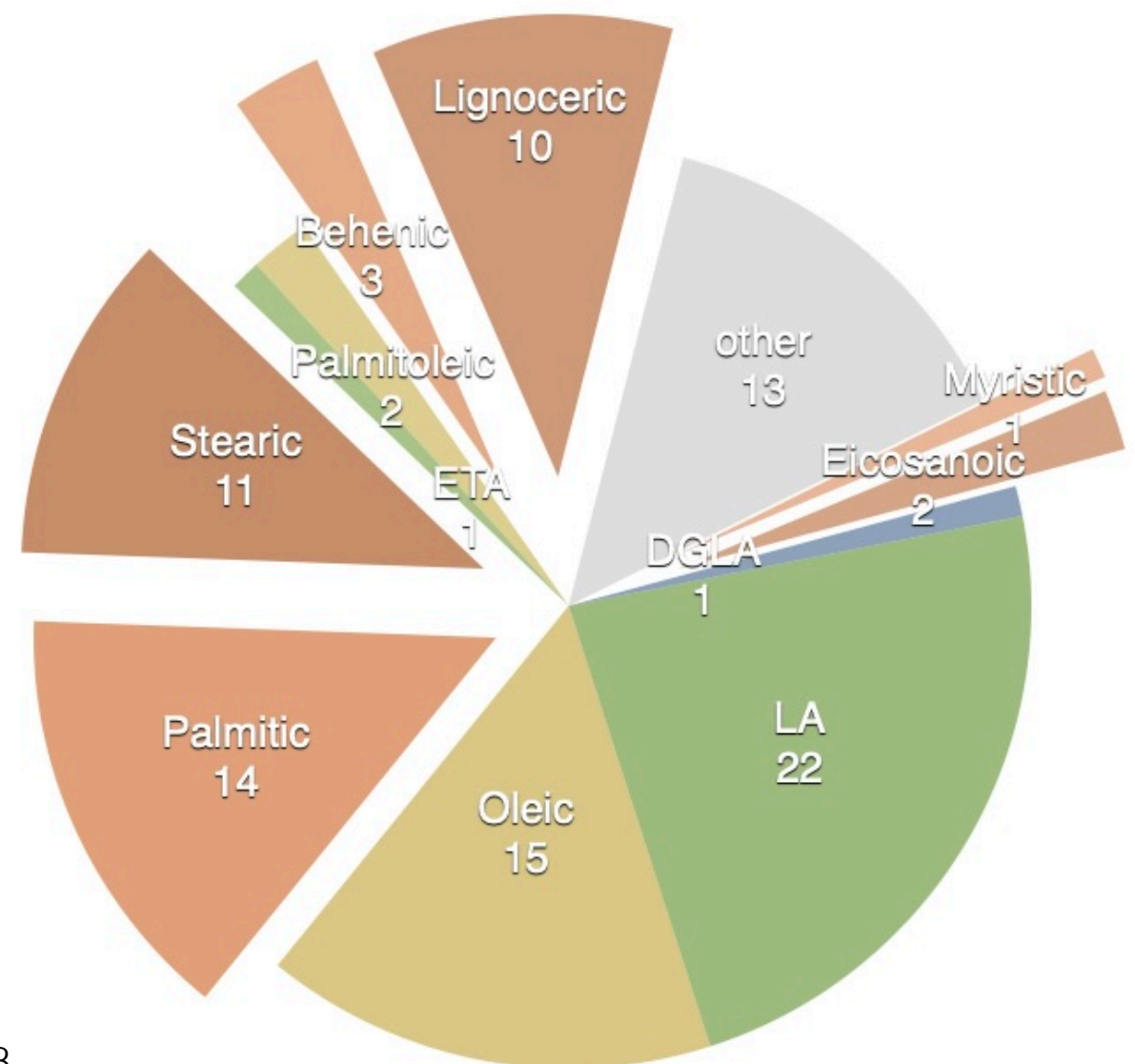
When absorbed into the skin, they interact with cellular receptors and modulate various pathways that control inflammation, tissue regeneration, barrier repair, and even microbial defense.

nature of signaling

SKIN LIPIDS -

EPIDERMIS

SATURATED FATTY ACIDS

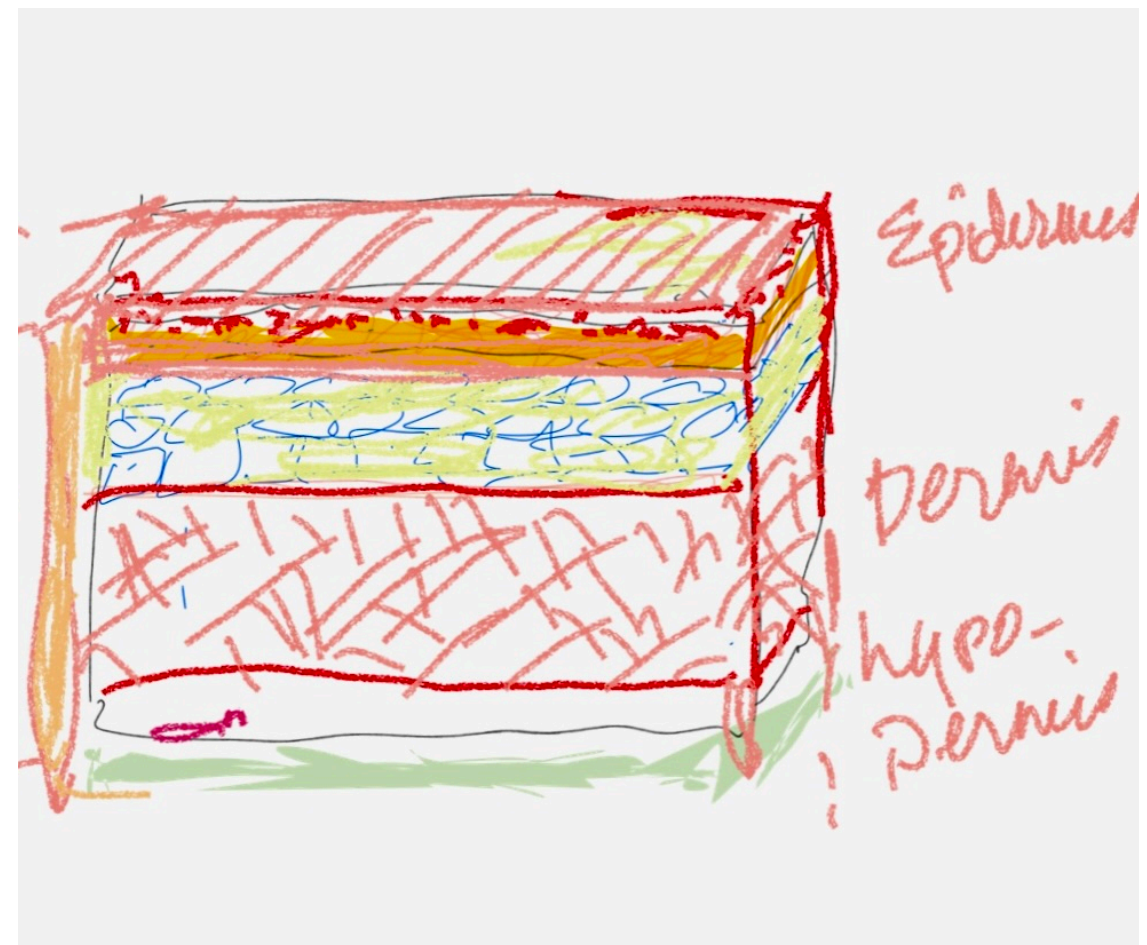


benefits for the skin

Triterpenes act as multi-functional skin benefactors:

- They calm inflammation by inhibiting pro-inflammatory enzymes
- stimulate skin repair and regeneration especially after wounding
- strengthen the skin barrier to function optimally, preventing TEWL.
- defend against environmental damage and invading pathogens
- and slow signs of aging by maintaining the normal functions of the skin layers, i.e., collagen

Triterpenes contribute many protective actions that contribute to skin repair, collagen and elastin support, resilience, and anti-aging.



common compounds

We will look closely at the most commonly found plant triterpenes in the following slides. In the list below, you can observe how the compounds diversify across different plants.

Oleanolic acid, Calendula, St. John's wort, Lavender, Elderflower, Lemon balm

Ursolic acid, Calendula, St. John's wort, Lavender, Elderflower, Lemon balm

Taraxasterol, Violet leaves, Dandelion, Comfrey,

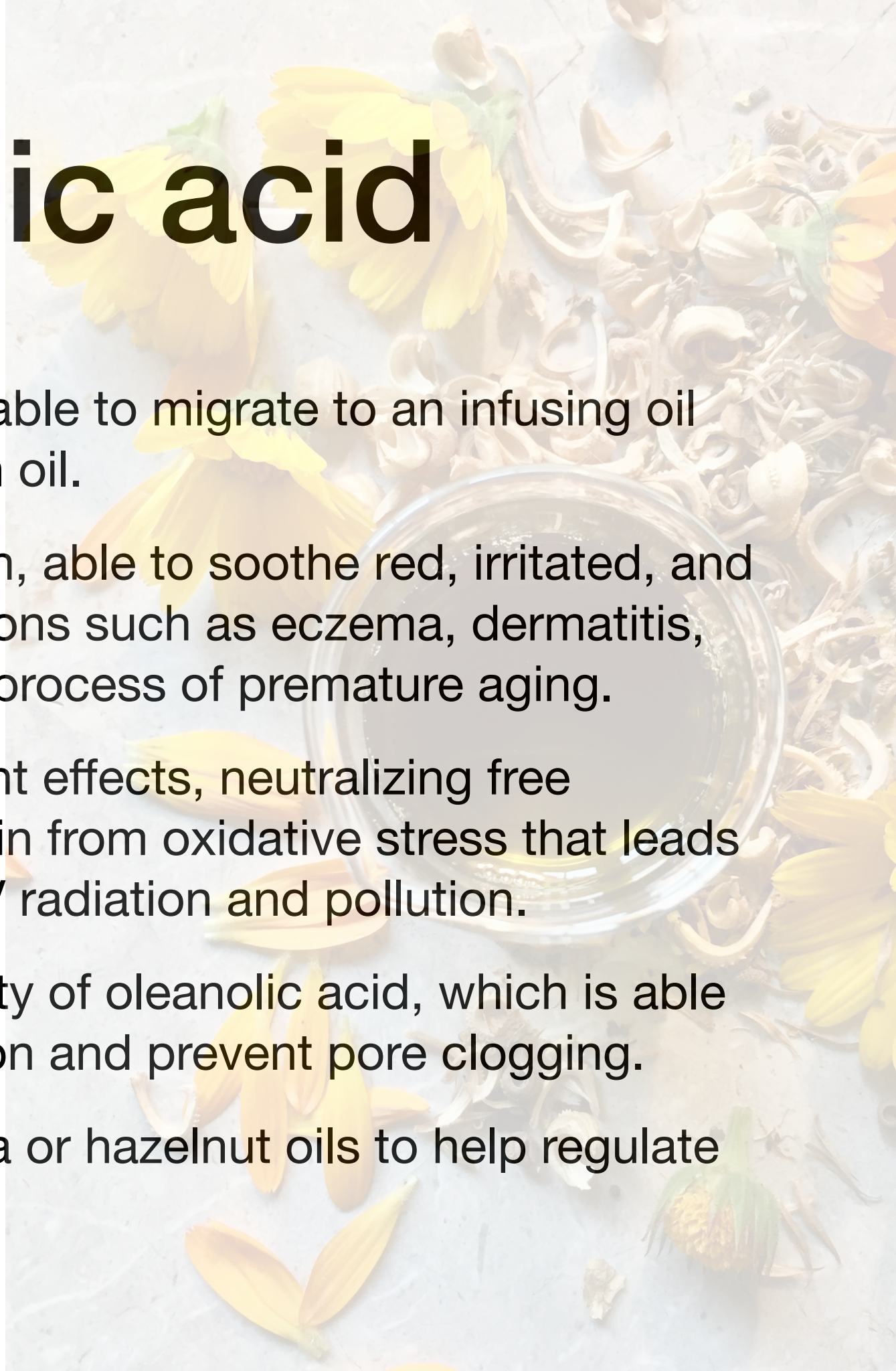
Lupeol, Violet leaves, Dandelion fl, Calendula, Comfrey, Mango peel,

β -amyrin, St. John's wort, Dandelion fl, Calendula, Comfrey,

α -amyrin, Calendula, Oregano, Licorice, Citrus peels, Burdock



oleanolic acid



Oleanolic acid is lipid soluble and able to migrate to an infusing oil when calendula flowers macerate in oil.

Oleanolic acid reduces inflammation, able to soothe red, irritated, and inflamed skin, particularly in conditions such as eczema, dermatitis, psoriasis, and acne, and slows the process of premature aging.

Additionally, it has potent antioxidant effects, neutralizing free radicals, which helps protect the skin from oxidative stress that leads to aging and damage caused by UV radiation and pollution.

Sebum regulation is another property of oleanolic acid, which is able to calm overactive sebum production and prevent pore clogging.

Pair calendula infusion with camellia or hazelnut oils to help regulate sebum and manage oily skin.

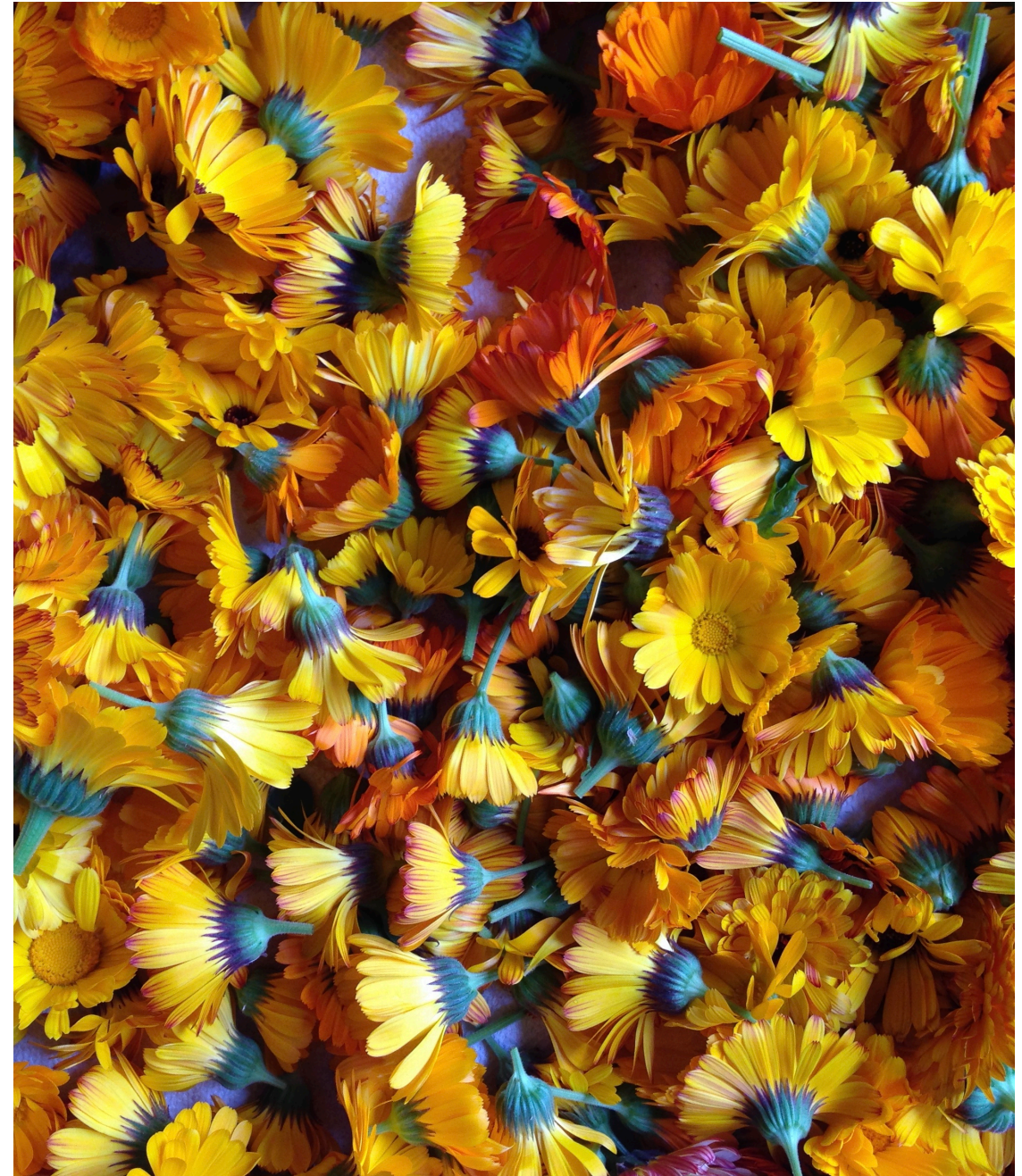
regenerative oleanolic

Oleanolic acid enhances regeneration of cells which includes collagen synthesis. Minor cuts and scars are rapidly healed as it rebuilds wounded tissues.

Oleanolic acid's mild antibacterial and antimicrobial properties reduce the chance of infections during the healing and regenerating process.

Also able to tamp down acne conditions where bacteria is a contributing factor in the acneic eruptions.

Mild UV protections from the compound help reduce damage to the skin, but it is not considered a sunscreen.



ursolic acid

Ursolic acid is a triterpenoid compound found in numerous plants and their infused oils; calendula, lemon balm, dandelion, violet, comfrey, lavender, St. John's wort, elderflower and basil.

Anti-inflammatory properties, can help reduce redness, irritation, and swelling in the skin. calming inflammatory skin conditions such as eczema, psoriasis, and acne.

Antioxidant properties, help to neutralize free radicals that cause oxidative stress, a significant contributor to skin aging, and the antioxidant activity of ursolic acid can help slow down the aging process by protecting the skin cells, improve the skin's elasticity and firmness, and contribute to a youthful appearance.

Wound Healing and Regeneration: Ursolic acid promotes skin regeneration and helps in wound healing. designed to treat minor cuts, abrasions, and scars. And it stimulates collagen synthesis, which is crucial for skin repair and elasticity.

Antibacterial: ursolic acid also has antibacterial properties, making calendula oil helpful for preventing and treating acne or any skin infections caused by bacteria.

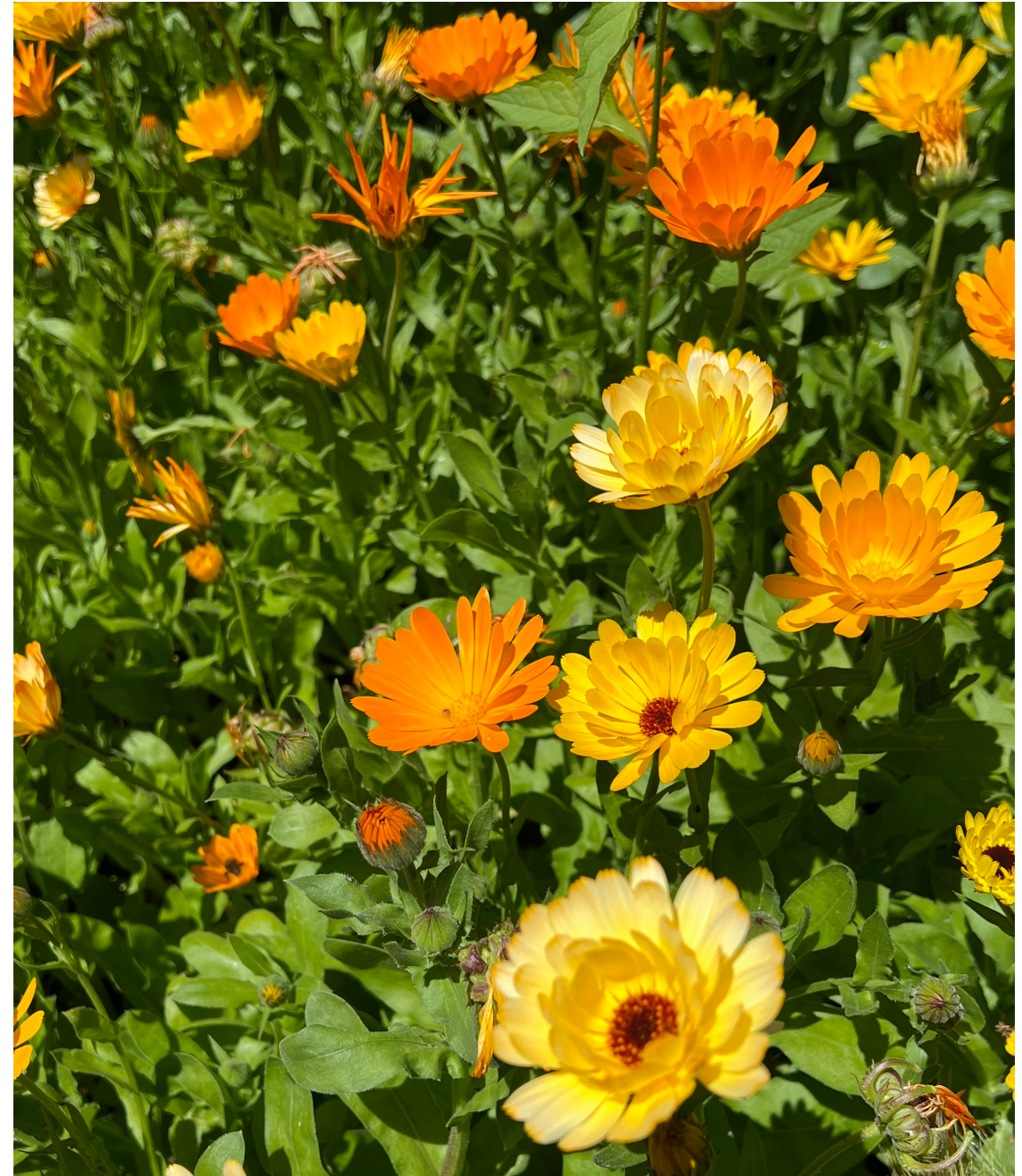
ursolic is resinous

Ursolic acid is the sticky resinous compound in calendula blossoms that makes fingers sticky after a prolonged session picking the blossoms.

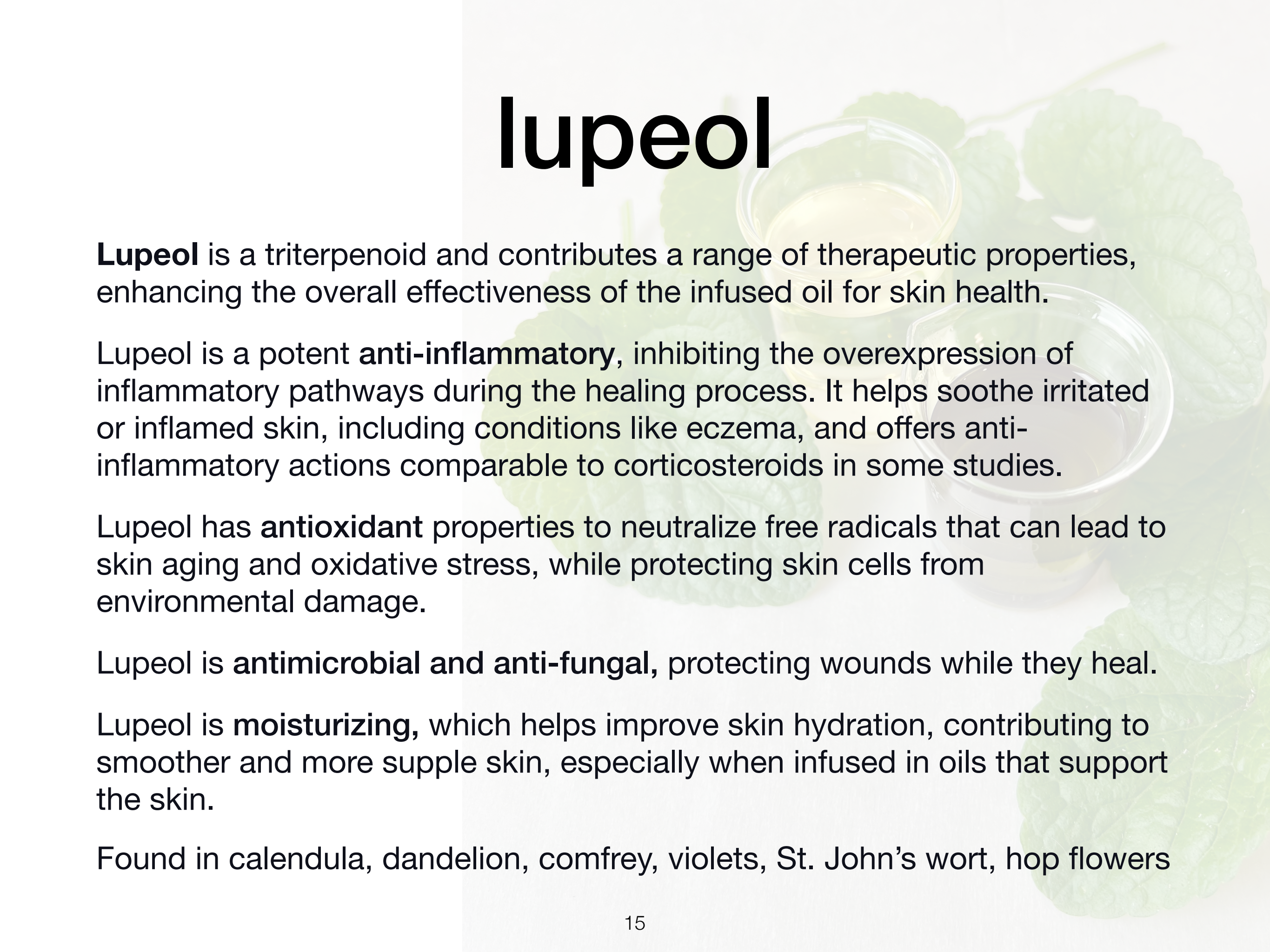
Calendula-infused oil with ursolic acid is particularly beneficial in soothing irritated skin, promoting faster healing of minor wounds, and improving overall skin tone and texture.

Often used in formulations for sensitive skin, anti-aging treatments, and scar healing, and applied to areas needing calming from inflammation, tissue repair, and general skin rejuvenation.

Calendula in the field



Lupeol



Lupeol is a triterpenoid and contributes a range of therapeutic properties, enhancing the overall effectiveness of the infused oil for skin health.

Lupeol is a potent **anti-inflammatory**, inhibiting the overexpression of inflammatory pathways during the healing process. It helps soothe irritated or inflamed skin, including conditions like eczema, and offers anti-inflammatory actions comparable to corticosteroids in some studies.

Lupeol has **antioxidant** properties to neutralize free radicals that can lead to skin aging and oxidative stress, while protecting skin cells from environmental damage.

Lupeol is **antimicrobial and anti-fungal**, protecting wounds while they heal.

Lupeol is **moisturizing**, which helps improve skin hydration, contributing to smoother and more supple skin, especially when infused in oils that support the skin.

Found in calendula, dandelion, comfrey, violets, St. John's wort, hop flowers

lupeol and collagen

In wound healing, **lupeol stimulates collagen production**, helping to speed the closing of wounds and returning the skin to normal.

Lupeol's role in wound healing indirectly enhances collagen production.

The fibroblast cells responsible for producing collagen are stimulated to support the formation of collagen fibers in the skin, which leads to improved skin structure and resilience.

During the repair of damaged skin, collagen is essential for rebuilding and strengthening the dermal matrix.

By promoting tissue regeneration, lupeol supports the formation of new collagen fibers in the healing process.

Dandelion flowers in oil



α -amyrin, β -amyrin

α -amyrin and β -amyrin are closely related pentacyclic triterpenoids with the ability to improve the condition of the skin and repair wounded areas.

They often appear together in plants in varying ratios, as part of resinous or waxy protective coatings, as we see with the cuticular waxes.

The ability of both to dissolve in lipid compounds enables them to alter membrane fluidity.

Embedded in skin lipid bilayers, they subtly impact the membranes.

Both compounds are highly lipophilic and infuse into maceration oils readily.

Lavender, white and purple



α -amyrin

α -amyrin is anti-inflammatory, helping to check over-exuberant inflammatory responses.

When wounds need healing, α -amyrin promotes keratinocyte migration, an essential aspect of supplying new cells to cover the wounded and exposed area to restore the skin's barrier function.

The compound can give damaged areas some relief from pain, having analgesic properties.

Regenerating the skin's barrier function and preventing TEWL, trans epidermal water loss, is a primary function of the compound.

Rosemary flowers



β -amyrin is anti-inflammatory and analgesic, soothing damaged skin similarly to α -amyrin.

Promotes barrier repair, helping restore lipid elements that make up the stratum corneum and barrier function.

Collagen support, synthesis, firmness, and elasticity are achieved by stimulating fibroblast activity, which is the maintenance of tissue structure and integrity.

Wound-healing and soothing, β -amyrin eases discomfort and sensitivity in damaged skin.

β -amyrin's antimicrobial actions disrupt bacterial membranes, a property beneficial for blemish-prone and irritated skin.

Dandelion flowers

β -amyrin



The plant, or phyto-sterols, of which there are over 250, are triterpenes.

Phytosterols are the plant-derived counterpart to cholesterol that forms in animals and humans.

Common sterols found in the unsaponifiable fraction of oils and the migrated compounds of herbs into oil are similar and provide a range of support for the skin.

They are antioxidants, aid the skin's healing process, and protect against damage from excessive UV exposure.

They can help maintain the skin's barrier function by enhancing moisture retention, keeping the skin hydrated, and protecting it against moisture loss.

And they are commonly transferred into oils during the infusion process because they are lipophilic.

phytosterols



common phytosterols

Beta-Sitosterol - Anti-inflammatory, antioxidant, strengthens the skin barrier, improves skin hydration, reduces signs of aging, such as fine lines and wrinkles —avocado oil, pumpkin seed oil, and wheat germ oil.

Campesterol - Antioxidant, promotes skin healing, and may help in reducing redness and irritation, —Sunflower oil, sesame oil, and corn oil.

Stigmasterol - Anti-inflammatory, skin repairing and rejuvenation, reduces oxidative stress in skin cells — sunflower oil, and flaxseed oil.

Spinasterol - Skin soothing, protects the skin from UV-induced damage, and is moisturizing —Spinach, sesame, and sunflower oils

Brassicasterol - Anti-inflammatory, regenerates skin after wounding, and enhances moisture retention—Canola oil, mustard oil, and rapeseed oil.



sterols for the skin

The benefits phytosterols provide the skin are due to their structural similarity to cholesterol, giving them the ability to interact with the skin's lipid barrier.

With the skin composed of half lipid compounds, the lipophilic plant sterols support the skin barrier in all its functions,

As anti-inflammatories and antioxidants, they can stimulate wound repair and skin healing, helping prevent the breakdown of the proteins that are collagen and elastin fibers.

UV protection: stigmasterol, specifically, may offer mild protection against UV-induced skin damage,

Beta-sitosterol in particular is known for its anti-inflammatory effects, calming irritated, inflamed, or reactive skin conditions like eczema, rosacea, and psoriasis.



saponins

The root of the word saponin comes from the Latin word for soap, *sapo*, reflecting the ability of the saponin compounds to produce soap-like lather when agitated in water.

Saponaria officinalis, also called soapwort, is a plant with a high percentage of saponins in its root.

With a surfactant nature, saponins bind to and remove dirt, oil, and impurities from the skin just as soap does, without stripping the natural oils.

And some saponins, like betulinic acid, stimulate collagen production, which is crucial for maintaining the skin's firmness and elasticity.



saponins, hydrophilic

Saponins fall into the triterpene group, and while primarily water-soluble, their extraction into infusing oils is possible.

They are a glycoside compound found in many plants, composed of a sugar molecule, glycone, and a non-sugar molecule, aglycone, which makes them hydrophilic.

Able to enhance skin regeneration by stimulating collagen production, saponins promote cellular turnover to accelerate the healing of cuts, burns, or scars.

In a process known as hydrophilic-lipophilic interaction, some oils, particularly those rich in phospholipids, can help draw the saponins out of plant material during the infusion process.



tetraterpenoid /carotenoids

Most of the tetraterpenoid group, the eight isoprene units of 40 carbon atoms, is made up of the carotenoids, the provitamin A plant compounds that are powerfully antioxidant on the skin.

Plant-sourced carotenoid compounds β -carotene, α -carotene, and β -cryptoxanthin produce vitamin A when ingested in the diet, where they are known as provitamin A.

On the skin, non-provitamin A carotenoids perform as antioxidants, but do not have the enzymes that can transform them into vitamin A on the skin's surface.

Carotenoids like astaxanthin and lycopene support collagen production, which contributes to skin elasticity and firmness, while also enhancing skin hydration.



β -carotene is the most familiar of the carotenoid group but all are exceptional antioxidants.

The carotenoids, beta-carotene, lutein, and zeaxanthin in particular, act as antioxidants, helping to protect the skin from free radical damage, reducing oxidative stress, and preventing premature aging.

Some carotenoids, like lutein, zeaxanthin, and astaxanthin, help protect the skin from the damaging effects of UV radiation, reducing sunburn, pigmentation, and the risk of skin cancer.

β -Carotene, Lutein, Lycopene, and Astaxanthin are the common forms of carotenoids found in plants and oils.

β -carotene



Beta-carotene is the most common precursor to vitamin A in the body, where it converts into retinol (vitamin A) through enzymatic processes in the liver. Alpha-carotene can also be converted into vitamin A, though it is less potent in this conversion.

Lutein is not a vitamin A precursor but is a known antioxidant, particularly in protecting the skin from blue light and UV radiation and helping maintain skin hydration and elasticity.

Zeaxanthin, has a unique ability to accumulate in the skin, where it provides a protective shield against light-induced oxidative damage protecting the skin from damage due to UV light exposure.

Astaxanthin is a potent antioxidant and known for its ability to protect the skin from UV damage, and has anti-inflammatory and collagen-boosting properties.

Lycopene helps protect the skin from UV-induced oxidative damage and inflammation, reducing redness and preventing premature aging.

carotenoids



When consuming adequate amounts of carotenoids, the skin retains a reservoir of vitamin A in the epidermis and dermis in the form of retinol and its derivatives.

These retinoids are essential for maintaining healthy skin functions, and the skin creates this reservoir to store them for later use.

Retinoids help regulate the rate at which skin cells divide and differentiate, promoting healthy, youthful-looking skin, and retinoic acid is essential for collagen synthesis.

Prolonged exposure to UV radiation, pollution, and other environmental stressors can deplete the skin's reserves of vitamin A.

A in the skin



more compounds

In the next lesson, we are going to take a brief look at compounds that do not fall within the terpenoid group or the polyphenol group, like chlorophyll.

These are a group of compounds that will inevitably grow with more research.

Nature is so broadly complex and with various molecules hooking up together to create compound compounds!! Like the following;

In St. John's wort, there are compounds called phloroglucinols that have relationships with both of our larger chemical groups, but do not fall neatly into one or the other.

So, that will have to wait until far more research into the chemistry of plants can be mastered.

