



Review of phytochemical constituents and pharmacological activities of the plant *Calendula officinalis* Linn.

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ABSTRACT

Calendula officinalis, a member of the Asteraceae family and also called Pot Marigold, is a fragrant herb used in Traditional Chinese Medicine to cure injuries, sores, herpes, scar tissues, skin problems, frost-bite, and blood purifying. It is primarily used for the treatment due to its numerous pharmacological properties such as analgesic, antihyperglycaemic, anti-ulcer, and anti-inflammatory. It is also used to cure gastrointestinal issues, obstetric issues, eye problems, skin wounds, and some instances of burns. Calendula oil is still being used therapeutically as an anti-cancer agent and a tissue repair cure. Calendula extracts have antiviral and anti-mutagenic activities in-vitro, according to plant pharmacological studies. Calendula in suspension or liquid form is being used topically in herbal remedies to treat skin conditions like acne, reduce swelling, regulate bleeding, and soothe irritated tissue. Internal use of an admixture or tincture of the flower petals is effective for the treatment of yeast infections and indigestion. *Calendula officinalis* infusion can also be used to cure insect bites, eye inflammatory disorders, boils and carbuncles, varicosities, dermatitis, and as a rinse for oral sores or tooth pain. Phytochemical screening has revealed the existence of several groups of compounds, the most important of which are triterpenoids, flavonoids, coumarins, quinones, volatile oil, carotenoids, and amino acids. This review investigated the sensory attributes, in-vitro, and in-vivo pharmacological properties, as well as the explanation, agricultural production, and active compounds of *Calendula officinalis*, in terms of enhancing the current knowledge on this plant and illustrate its multiactivity characteristics as a therapeutic plant.


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Introduction

Calendula officinalis, a member of the Asteraceae family, is a common medicinal herb. It's also known as English marigold and pot marigold. It contains a variety of biologically active components, including carotenoids, flavonoids, saponins, sterols, phenolic

acids, lipids, and others. Numerous parts of the plant, such as flowers and leaves, have been observed to have medicinal properties [1] (**Figure 1, 2, and 3**). Unique pharmacologically active chemical components such as isorhamnetin, rutin, and quercetin glucoside have been isolated using advanced statistical methods. These are used in the food and skincare industries [2]. The yellow or orange flowers are used as nutrition, colorant, flavor, tea, lotion, or moisturizer in cosmetics. *Calendula officinalis* has historically been used as an anti-inflammatory, diaphoretic, analgesic, antiseptic, and in the treatment of jaundice [3]. It should be noted that the flowers have been observed to be the medicinally most potent part. It is used to treat inflammation in the mucus membrane, stomach ulcers, gastrointestinal cramps, peptic and intestinal mucosa cramps, painful menstruation, particularly in anxious or anemic women, as well as kidney and liver inflammatory diseases [4]. In most cases, it is used externally to treat skin inflammation and pain, open sores, and puncture wounds with blood loss [5]. The traditional uses and therapeutic prospects of *Calendula* species are highlighted in this review. The review aims to raise the awareness of natural substance researchers all over the world about the possibilities of the *Calendula* species. This genus must be thoroughly explored in order to be utilized as therapeutic drugs [6].



Figure 1. Pictorial representation of Leaves of *Calendula officinalis* Linn.

Classification of *Calendula officinalis* [7]

Kingdom-Plantae

Subkingdom-Tracheobionta

Division-Magnoliophyta

Class-Magnoliopsida

Subclass-Asteridae

Order-Asterales



Figure 2. Pictorial representation of stem of *Calendula officinalis* Linn.



Figure 3. Pictorial representation of flower of *Calendula officinalis* Linn.

Family-Asteraceae

Tribe-Calenduleae

Genus-*Calendula*

Species-*officinalis*

Synonyms [8]

Pot marigold, English marigold, Bride of the Sun, bull flower, butterwort

Botanical Description

Calendula officinalis is a fragrant perennial herb that grows to 80cm in height with minimally branched lax or upright stems. The leaves are oblong-lance in shape. The disc inflorescences are tube-shaped and bisexual, 5-17cm long, hairy on both edges, and with margins that are continuous or sometimes waved or mildly toothed [9]. The flowers are yellow, with a thick capitulum or floral head 4-7cm in diameter enclosed by two rows of hairy bracts; in the wild plant, there is an only one structure of ray inflorescences enclosing the central disc florets—yellow color than the female, tridentate, ancillary flowers [10]. Where circumstances allow, the flowers may bloom throughout the year. The fruit is an arched prickly achene. *Calendula officinalis* has a light and fragrant aroma. It has a bitter flavor [11].

Cultivation

The plant is indigenous to Central and Southern Europe, Western Asia, and the United States. *Calendula officinalis* is extensively planted and can be managed to grow in most soil types and blazing hot locations. Although it is continual, it is generally treated as an annual, especially in cold areas where winter subsistence is poor and in warm summer climates where it also does not sustain [12]. Many planting experts believe calendulas to be among the simplest and most adaptable flowers to plant in a garden, owing to their tolerance to most soils. Seeds are scattered in mild climates in the spring for flowers that last all summer and also into the autumn. Seeds for winter are planted in autumn in environments with minimal winter cooling [13]. Plants deteriorate in the subtropical warmer months. Plants do better in bright areas with rich, well-drained compost, but seeds proliferate voluntarily in sunny or half-sunny areas. Pot marigolds generally flower rapidly (in less than two months) from seeds in vibrant yellows, golds, and oranges [14].

Calendula Care

Unless you survive in temperate zones 9 to 11, calendula is mainly an evergreen plant. Calendula favors full sun, but it can wilt during the warm days unless it gets some midday shade. Calendula, like most representatives of the Asteraceae family, requires well-drained soil rich in organic matter. Wet and thick soils can cause rootstocks [15]. This plant can accommodate a wide range of soil pH levels but chooses mildly acidic to neutral soil (6.0 to 7.0). Water the plants regularly until they are formed. Mature plants can grow with only infrequent watering. Prevent overwatering these plants. Calendula favors mild daytime temperatures and may start dying by the end of the season in

extremely hot environments. A winter storm will destroy these plants [16]. If you anticipate cold weather for a day or two, protect the plants with a winter duvet overnight and then expose them as the sun heats the wind the very next day. Three to four inches of compost will also safeguard the plants from low temperatures. Calendula does not require much nutrition and hydration [17]. It does not require any special feeding if sown in nutrient-rich garden soil. Marginal soil types may necessitate feeding with a stable, liquid-soluble fertilizer, but over-feeding can cause plants to become tall and slender. The vessel plant needs monthly fertilization with a dissolved and balanced fertilizer [18].

Calendula grows very easily from seeds, which fertilize and sprout quickly. Flowers' seeds can be protected and regrown; the plants will also self-seed in the yard. Initiate calendula seeds within six to eight weeks before the last winter date in a seed booster mix. Alternatively, you can immediately sow them into the yard just before the last low freezing date [19]. The majority of plants flourish within two months of being seeded. In the yard, these plants frequently self-seed; don't confuse the plantings for undergrowth. Although the term "pot marigold" relates to the plant's conventional use in food preparation, calendula is also widely cultivated in pots, where it flourishes. Most variants, especially dwarf varieties, develop well in vessels [20]. Prepare a mixture of half potting soil and half organic manure, or use any well-draining, organic compost soil. Because this plant dislikes being wet, keep in mind the pot has a number of holes in the bottom. Potted plants require constant feedings of an equitable fertilizer. Calendula is an outstanding vegetable garden assistant plant because it captivates pollinating insects such as bees and bumblebees, as well as beneficial organisms [21]. Butterflies are drawn to the vibrant blooms. Calendula has no major arthropod or disease issues. Powdery mildew can occasionally affect the plant, but good air flow can help. Drones and crawlers may consume the plants, particularly when they are energetic. To reduce this damage, keep the floor free of debris. Larvae and whiteflies can be a nuisance at times. Sprinkle them with water or cure them with insecticidal washing-up liquid to keep them at bay [22].

Calendula varieties [23]

Calendula officinalis comes in a variety of cultivars.

- Pink Surprise: Has ruffled gold and yellow flowers with pink edges and dark apricot centers.
- Touch of Red: Flowers with a mixture of orange and red color with red-tipped petals.

- Greenheart Orange: Flowers with orange petals surrounding lime-green hubs; a very unusual-looking plant.
- Greenheart Orange: Flowers with orange petals surrounding lime-green centers; a very unusual-looking plant.
- Citrus Cocktail: A compressed, short plant with yellow and orange blossoms; appears to work well in vessels.
- Dwarf Gem: A convenient variety with orange, yellow, and apricot double-petal flowering; another excellent selection for containers.
- Prince: Is a giant, heat-tolerant range with orange and yellow flowers.
- Golden Princess: Bright yellow flowers bloom with a contrasting black center.

Edible uses

When consumed, they initially instill a viscid sweet taste, accompanied by a solid lacerating saline flavor. They are high in vitamins and minerals, and their nutritional content is comparable to that of *Taraxacum officinale* (Dandelion). Finely chopped fresh petals are incorporated into salads. The dried petals have a stronger flavor and are being used as a flavoring agent in soups, pastries, and other dishes. Vitamins A and C are abundant [24]. The petals are used to make an eatable yellow dye. It is a saffron alternative that is used to provide sensory attributes to rice, soups, and other dishes. It can also be used as a hair wash to add golden highlights to brown or crimson hair. Tea is made from the petals and flowers, with the petals being less bitter. There is no evidence that the seed is fit for human consumption, but it incorporates up to 37% protein and 46% oil [25].

Medicinal uses

Pot marigold is a well-known and adaptable herb in Modern herbal medicine, as well as a popular home remedial measure. It is primarily used to treat skin issues, such as insect bites, torn ligaments, lacerations, eye irritation, varicose veins, and so on. It is also a purifying and exfoliating herb that is used to treat high fever and chronic infections [26]. Only the common deep-orange colored flower range is thought to be medically beneficial. The entire plant is antiphlogistic, disinfectant, antispasmodic, aperient, astringent, cholagogue, diaphoretic, emmenagogue, skin, stimulant, and vulnerary. The leaves can be used fresh or dried, and they are better cultivated in the morning of a beautiful sunny day, just after the moisture has evaporated [27]. The flowers can also be used fresh or dried; for drying, they should be cultivated when wide open and dried rapidly in the dark. A tea made from the petals improves blood circulation and, when taken

continually, can help with varicose veins. Applying crumbled stems to corns and lesions will soon make them easy to remove [28]. Homeopathic remedies are made from leaves, flowers, and buds. It is used internally to reduce swelling and inflammation. *Calendula officinalis* has been approved by the German Commission E Monographs, a medicinal handbook to herbal medicine, for the inflammatory response of the mouth and pharynx (throat), lacerations, and burns [29].

Other uses

The rising plant functions as an insect repellent, reducing the population of soil eelworms. The flowers are used for cosmetic purposes. They can be used in skin moisturizers and hair products to brighten up the color of the hair. The flowers are an optional ingredient in the compost activator 'Quick Return.' This is a dried and powdered herb combination that can be introduced to a compost pile to increase the bacterial load and thus reduce the amount of time required to make compost [30]. Boiling the flowers yields a yellow dye. The plant produces essential oil. Because of the difficulties in finding it, it is used infrequently in perfumes with a sharp aroma. The flowers end when wet conditions are expected, and they can thus be used as a harsh weather prediction tool [31].

Ethnopharmacology

Calendula officinalis Linn. has conventionally been shown to cure internal organ inflammations, gastric ulcers, and menstrual irregularities, as well as a diuretic and sweat stimulant in seizures. It is also used to treat oropharyngeal mucosal inflammations, as well as lacerations and burns. *Calendula* is a purifying and exfoliating herb, and the infusion can be used to cure serious illnesses [32]. The dehydrated blossoms have antipyretic, anti-cancer, and concealing properties. In injuries, scars, wrinkles, sprains, and eye infections, a topical floral infusion is being used as an antifungal and antiseptic. *Calendula* tea is used to treat eyewashes, gargles, undies rashes, and other inflammation of the skin and mucous membrane conditions. *Calendula officinalis* mother tincture is used in homeopathic medicine to treat mental stress and sleeplessness [33].

Calendula officinalis' therapeutic uses have been stated in Ayurvedic and Unani systems of medicine, with blossoms being antipyretic, anti-inflammatory, antiepileptic, and antibacterial. *Calendula officinalis* is being used in conventional and homeopathic remedies medicine to treat poor vision, dysmenorrhea, varicosities, hemorrhoids, and peptic ulcers [34]. *Calendula* flowers have been

used in the Middle Ages to treat hepatic obstructions, snake bites, and boost the heart. It was used as a cure for headaches, jaundice, and red eyes in the eighteenth century. During the civil conflict, this plant was used to heal wounds and as a treatment for measles, chicken pox, and jaundice [35].

Phytochemical screening of *Calendula officinalis*

Several phytochemical analyses have well noted the existence of various classes of chemical compounds in the plant, the most important of which are terpenoids, flavonoids, coumarin, quinines, volatile oil, carotenoids, and amino acids. The pharmacological activities shown by these phytochemical constituents are given in **Table 1**.

Quinones: Quinones found in *Calendula officinalis* included plastoquinone, phyloquinone, and tocopherol in the chloroplast, ubiquinone, tocopherol in the mitochondria, and phyloquinone in the leaves [36].

Flavonoids: Several flavonoids have been separated from the ethanolic extract of *Calendula officinalis* flowers. They encompass quercetin, isorhamnetin, isoquercetin, isorhamnetin-3-O-D-glycoside, narcissin, calendoflaside, calendoflavoside, calendoflavobioside, rutin, isoquercetin neohesperidoside, isorhamnetin-3-O-2G-rhamnosyl rutinoside, isorhamnetin-3-Orutinoside and quercetin-3-O-rutinoside [37].

Carbohydrates: The occurrence of polysaccharides, PS-I,-II, and III with a (1-3)-D-galactam backbone and short side chains at C-6 comprising-araban(1-3)-araban and alpha-L-rhamnan-(1-3)-araban, was discovered in an ethanolic extract of the plant's inflorescence [38].

Coumarins: Coumarins-scopoletin, umbelliferone, and esculetin were found in an ethanolic extract of *Calendula officinalis* inflorescence [39].

Amino acids: The existence of 15 amino acids in a pure state has been observed in an ethanolic extract of the plant's blossoms: alanine, arginine, aspartic acid, asparagines, valine, histidine, glutamic acid, leucine, lysine, proline, serine, tyrosine, threonine, methionine, and phenylalanine. The amino acid concentration of the leaves is approximately 5%, the stems are 3.5 percent, and the flowers are 4.5 percent [40].

Terpenoids: The petroleum ether extract of *Calendula officinalis* flowers has been found to contain a variety of terpenoids. Sitosterols, stigmasterols, diesters of diols, 3-monoesters of

taraxasterol, lupeol, erythrodiol, brein, ursadiol, faradiol-3-Omyristate, calendula glycosideA 6-O-n-methyl ester, calendula glycoside C 6-O-n-butyl ester, calenduloside F6-O-n-butyl ester, calenduloside G6-O-n-methyl ester, and glucuronides (mainly found in flowers and green parts) F, D, D2, C, B and A are some of them. Cornulacic acid acetate was extracted from flowers as a new triterpenic ester of the oleanane series [41].

Lipids: The lipids in a petroleum ether extract of *Calendula officinalis* seeds, leaves, and flowers were studied. The seeds contained 15.7 percent neutral lipids, 0.6 percent phospholipids, and 0.9 percent glycolipids. Lauric, myristic, palmitic, stearic, oleic, linoleic, and linolenic acid were the fatty acids of monols, sterol esters, 3-monoesters, and 3-monoester diols found in flowers. Marigold seed fatty acids contain approximately 59 percent conjugated trienic acid and approximately 5 percent 9-hydroxy-18:2 acid-dimorphecolic acid. D-(+)-9-hydroxy-10,12-octadecadienoic acid was another oxygenated fatty acid found in *Calendula officinalis* seed oil [42].

Volatile oil: *Calendula officinalis* flowers carry the maximal volatile oil (0.97 percent) during the complete flowering stage and the least during the pre-flowering stage (0.13 percent). The proportion also demonstrated various trends at various stages of the vegetative loop. The volatile oil contains the following monoterpenes and sesquiterpenes. The essential oil was found to be high in α -cadinene, α -cadinol, t-muurolol, limonene, and 1,8-cineol, with lower levels of p-cymene at post-flowering stages [43].

Carotenoids: The methanolic extract of *Calendula officinalis* flowers' leaves, petals, and pollens revealed a variety of carotenoids. The carotenoids identified in the pollens and petals included neoxanthin, 9Z-neoxanthin, violaxanthin, luteoxanthin, auroxanthin, flavoxanthin, 9Zanthroxanthin, lutein, 9/9A-lutein, 13/13Zlutein, α -cryptoxanthin, lycopene, α -carotene. The total carotenoid content (mg/g dry weight) of the petals was 7.71 percent and the pollen content was 1.61 percent. The carotenoid compositions of the leaves and stems were observed to be neoxanthin, 9Zneoxanthin, violaxanthin, luteoxanthin, 9Zviolaxanthin, 13Z-violaxanthin, antheraxanthin, mutatoxanthin epimer 1, mutatoxanthin epimer 2, lutein, 9/9"2-lutein, β -carotene [44]. Total carotenoids (mg/g dry weight) are 0.85 percent in the leaves and 0.18 percent in the stems. The flavonoids were dominated by quercetin and isorhamnetin glycosides, while beta-carotene and lutein were the most plentiful carotenoids. The carotenoid concentration of *Calendula officinalis* petals was studied. Extracts of petals from orange

Table 1. Phytochemical constituents along with their exhibiting pharmacological activities.

Phytochemical Constituent	Pharmacological Activity	References
Quinones	Anti-cancer	[47]
Flavonoids	Antioxidant Anti-inflammatory Hepatoprotective	[48]
Carbohydrates	Anti-inflammatory Immunostimulant	[49]
Coumarins	Antioxidant Anti-inflammatory Anti-cancer	[50]
Amino acids	Anti-cancer	[51]
Terpenoids	Cardioprotective Anti-diabetic Anti-inflammatory Anti-tumor	[52]
Volatile oils	Antioxidant	[53]
Carotenoids	Antioxidant Anti-cancer Spasmolytic Anti-helminthic Wound healing Genotoxic	[54]

and yellow-flowered calendula varieties were found to contain nineteen carotenoids [45].

Furthermore, ten carotenoids were found only in orange-flowered varieties. The ultraviolet (UV) visible absorption maxima of the ten carotenoids were at an extended wavelength than flavoxanthin which is the main carotenoid of calendula petals, indicating that these carotenoids are accountable for the petals' orange color. Six carotenoids had cis structures at C-5, and it is possible that these (5Z)-carotenoids are catalytically isomerized at C-5 in a pathway distinct from the primary carotenoid metabolic pathway. Among them are (5Z, 9Z)-lycopene, (5Z, 9Z, 5'Z, 9'Z)-lycopene, (5'Z)-gamma-carotene, and (5'Z, 9'Z)-rubixanthin [46].

Pharmacological activities

Pharmacological research has established that *Calendula officinalis* has a wide spectrum of pharmacological effects, and some are very promising for continued development. The cellular mechanism associated with some of the pharmacological properties is presented in **Figure 4** and **Table 2**.

Cardioprotective activity

Calendula officinalis may have cardioprotective properties against coronary heart disease. Calendula provides protection to the heart by

increasing left ventricular evolved pressure and aortic flow, as well as decreasing the size of myocardial infarctions and cardiomyocyte apoptosis. Cardioprotection seems to be obtained by converting an ischemia-reperfusion-mediated fatality signal into a survivorship signal via antioxidant and anti-inflammatory sequence modulation, as demonstrated by the stimulation of protein kinase B and B-cell lymphoma 2 and the suppression of Tumor Necrosis Factor. The findings support the use of natural ingredients in degenerative diseases such as ischemic heart disease [55].

Anthelmintic activity

Calendula officinalis dehydrated flowers and leaves possess anthelmintic activity. The decoction was used to create an aqueous extract of dehydrated flowers and leaves of *Calendula officinalis*. Because of its biological or physical similarities to the human gut roundworm parasitic organism, the assay was carried out on Indian adult earthworms. The crude extracts of *Calendula officinalis* blossoms and leaf extracts illustrated unconsciousness at 56.5 minutes and worm destruction at 111.2 minutes. The plants produce saponins and have shown anthelmintic ability, which is consistent with previous findings that saponins have anthelmintic properties [56].

Anti-diabetic and Anti-hyperlipidemic activity

Diabetes was instilled in rats through an injection of alloxan (150mg/kg body weight) intraperitoneally. When diabetic rats were given a hydro alcoholic extract of *Calendula officinalis* at doses of 25 and 50mg/kg body weight, the blood sugar level and urine sugar levels were considerably lower when compared to a control group of diabetic rats. The extract raises total hemoglobin levels. The extract was comparable to insulin. Consequently, the study clearly demonstrates that a hydro alcoholic extract of *Calendula officinalis* has both anti-diabetic and anti-hyperlipidemic properties [57].

Antioxidant activity

Oral administration of Calendula alcoholic extract inhibited superoxide production in macrophages in female Swiss albino mice by 12.6 percent and 38.7 percent at doses of 100 and 250 mg/kg body wt, respectively. Catalase activity was significantly enhanced in mice after one month of treatment of *Calendula officinalis*. The extract significantly increased glutathione blood levels in the liver. Glutathione reductase was reported to increase, whereas glutathione peroxidase was observed to be reduced after the Calendula extract regime [58].

Anti-inflammatory and anti-oedematous activity

When compared to indomethacin, the ethyl acetate soluble fraction of the methanol extract of *Calendula officinalis* flowers inhibited 12-otetradecanoyl phorbol-13-acetate-induced inflammation (1 g/ear) in mice with an ID₅₀ valuation of 0.05 - 0.20 mg/ear. Besides that, activity-guided extraction revealed that its activity was primarily attributed to oleanane-type triterpene glycosides. A concentration of 1200g/ear of an aqueous-ethanol extract inhibited croton oil-induced mouse fluid retention by 20%. The appearance of triterpenoids was related to the activity, with the three most bioactive components being the esters of faradiol-3-myristic acid, faradiol-3-palmitic acid, and 4-taraxasterol [59].

A dichloromethane extract of the plant's inflorescence hindered croton oil-induced fluid retention, and an additional extraction revealed that the esters of faradiol-myristic acid, faradiol-palmitic acid, and -taraxasterol had antioedematous property, with an oedema inhibitory activity of around 50% at 240 g/cm². Calendula extract lotion has been shown to be efficient in dextran and destroying oedemas, as well as acute lymphoedema in rats. The property against lymphoedema was mainly ascribed to an increase in macrophage proteolysis [60].

Immunostimulant activity

Depending on an in-vitro granulocyte assessment, the polysaccharide percentage of *Calendula officinalis* extract demonstrated immunostimulatory property. At a dosage of 10⁻⁵ - 10⁻⁶ mg/mL, polysaccharide III exhibited strong phagocytosis (54 - 100 percent), while PS-I and PS-II demonstrated 40 - 57 and 20 - 30 percent phagocytosis, respectively [61].

Hepatoprotective activity

In 30 male albino rats, an 80 percent methanol extract of *Calendula officinalis* leaves was tested against paracetamol-induced liver injury. At a dosing regimen of 1gm/kg, paracetamol causes 100% death rates in mice, whereas pre-treatment with *Calendula officinalis* (1.0 gm/kg) lowered death rates to 30%. The pre-treatment of mice with leaf extracts (500mg/kg orally, 4 doses at 12-hour intervals) avoided the paracetamol (640mg/kg) induced increase in serum transaminases, serum bilirubin, and serum alkaline phosphatase (p<0.05). Three consecutive dosages of leaf extract (500 mg/kg. 6 hourly) reduced the liver damage caused by paracetamol (p<0.05) [62].

Spasmolytic and spasmogenic activity

When tested in rabbit jejunum, an aqueous-ethanol extract of *Calendula officinalis* flowers induced a dose-dependent (0.03 - 3.0 mg/mL) relief of sudden and K⁺-induced compressions; an additional extraction process with dichloromethane demonstrated an inhibitory activity of sudden compressions in a dosages range of 0.01 - 0.3 mg/mL. This is ten times stronger than the parent crude extract, and the spasmolytic property was discovered to be partly related to calcium channel blockers. The aqueous portion of the parent extract, on the contrary, demonstrated spasmogenic function at doses ranging from 1 to 10 mg/mL [63].

Wound healing activity

The ethanolic extract of the flower petals was tested on rats with chemically-induced burn wounds. Among the multiple extract doses (20, 100, and 200 mg/kg body weight), the 200 mg/kg dose improved wound healing significantly, as evidenced by the rise in collagen hydroxyproline and hexosamine composition. Alanine and aspartate transaminase levels, as well as acute-phase proteins, declined substantially. The reduction in lipid peroxidation could be attributed to its antioxidant properties. Because of its antimicrobial and antioxidant properties, routine usage of 2% calendula lotion led to an increased percentage of wound healing [64].



Figure 4. Pharmacological activities exhibited by *Calendula officinalis* Linn.

Table 2. Cellular mechanisms associated with specific pharmacological activities

Pharmacological Activities	Mechanism of action	References
Spasmolytic and Spasmodic	<ul style="list-style-type: none"> Calcium channel blocker Cholinergic property 	[68]
Antidiabetic and Antihyperlipidemic	<ul style="list-style-type: none"> Lowers blood serum and lipid levels Activates increased insulin secretion from pancreas 	[69]
Hepatoprotective	<ul style="list-style-type: none"> Decreases hepatocytolysis Reduces enzyme changes 	[70]
Anti-cancer	Leutin increases tumor latency	[71]
Antioxidant	Scavenges free radicals to prevent DNA damage	[72]
Wound healing	Increases collagen synthesis	[73]
Anti-inflammatory	<ul style="list-style-type: none"> Antioxidant action against macrophage Modulates cytokines Inhibits COX-2 gene 	[74]
Antifungal	<ul style="list-style-type: none"> Inhibits growth Comparable to fluconazole 	[75]
Antimicrobial	<ul style="list-style-type: none"> Inhibits growth Comparable to ciprofloxacin 	[76]
Immunomodulatory	May inhibit growth factor or cell surface molecules of lymphocytes	[77]
Antiviral	Extract reduces HIV- a reverse transcriptase activity	[78]

Anti-cancer activity

Flavonoid extracts (0.05-50g/ml) had no impact on cell expansion in two different cell lines. It could be connected to the flavone's linked sugar moiety at position 3, which can decrease its potential to adhere to aromatase and other enzymes. *Calendula officinalis* saponins were isolated and characterized. Antimutagenic activities were also evaluated by comparing chlorophyllin activity. For a dose of 400ug/kg, all saponins were considered to be non-toxic and non-genotoxic [65].

Genotoxic and Anti-genotoxic activity

Calendula officinalis flower aqueous, aqueous-ethanol, ethanol, and chloroform extracts were tested to see if they activated unscheduled DNA synthesis (UDS) in rat liver culture and reversed diethylnitrosamine-generated UDS. In the UDS experiment in liver culture, diethylnitrosamine generated a maximization goal of 40% 3-Hthymidine integration at a concentration of 1.25 mole, whereas aqueous and aqueous-ethanol extracts completely reversed the impact of diethylnitrosamine at concentrations of about 50 ng/mL and between 0.4 and 16 ng/mL, respectively [66]. In the unavailability of diethylnitrosamine, these two polar extracts activated UDS in rat liver cultured cells at a concentration level of 25 and 3.7-100 g/mL for aqueous and aqueous-ethanol, respectively. Thus, at low doses, these polar excerpts demonstrated antigenotoxic effect, whereas, at high doses, they demonstrated genotoxic effect. Selected on the basis of young growing pigs that included the evaluation of lymphocyte DNA division and 24 h urinary 8-hydroxy-2'-deoxyguanosine, the propylene glycol extract of *Calendula officinalis* also demonstrated antigenotoxic effect [67].

Conclusion

The details on the botanical characteristics, conventional uses, phytochemical analysis, and pharmacological evaluation of *Calendula officinalis* Linn. (Asteraceae), a medicinal herb, are demonstrated in this review. This plant contains a variety of therapeutically bioactive components, including carotenoids, flavones, glycosides, steroids and sterols, quinines, essential oils, and amino acids. This plant's extract, and a substance extracted from it, have been shown to have a variety of pharmacological properties, including anti-tumor, hepatoprotective, and antispasmodic properties, and many others. Acute bioassays in mice and rats demonstrate that the extricate is not poisonous. Animal tests revealed negligible skin inflammation, as well as no hypersensitivity or phototoxicity. One

preparation caused marginal eye inflammation, while others caused none. Clinical trials of skincare preparations containing the extract revealed no discomfort or hypersensitivity. It has the potential to be an effective medicinal herb for humans. This plant has still some potential for other pharmacological activities to be explored with different extracts.

Contribution of authors

We proclaim that this work was completed by the authors mentioned in this article and that the authors will bear all liability for aspects relevant to the content of this article. Ms. Garima Dhingra compiled the article's content from various research papers published yet. Ms. Sonia Tanwar and Dr. Prashant Dhakad authenticate the entire manuscript and recommended changes, as well as assisted in the layout of the manuscript.

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Conflict of interest

None

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