Calendula officinalis in Traditional and Modern Medicine: A Review of Its Bioactive Compounds

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Abstract:

Calendula officinalis Linn., also called pot marigold, is a member of the Asteraceae family and is valued for its bright yellow-orange flowers that are used as ornaments, medicines, and food. Widely grown in temperate climates worldwide, this annual plant grows in sunny conditions with a variety of soil types. The plant's erect stems, lance-shaped leaves, and colourful flower heads are among its distinctive physical traits. Because of its anti-inflammatory, antipyretic, and antibacterial qualities, *C. officinalis* has been used historically in traditional medical systems like Ayurveda and Unani. Its effectiveness in treating a range of illnesses, such as gastrointestinal ulcers, skin disorders, and musculoskeletal injuries, has been demonstrated by recent pharmacological research. Essential oils, carotenoids, flavonoids, and amino acids are among the bioactive substances of *C. officinalis* that support its potential for medicinal use. *Calendula officinalis* botanical profile, traditional usage, and pharmacological actions are explained in this comprehensive review, highlighting the plant's importance in modern herbal medicine and its potential usefulness in pharmacotherapy for inflammatory and oxidative illnesses.

Keywords: *Calendula Officinalis*, Phytoconstituents, Pharmacological activities, traditional uses

Introduction:

Calendula officinalis Linn. is a member of the asteraceae family. It's an annual with vivid or orange-yellow daisy-like flowers that are utilized for both decorative and therapeutic uses, particularly in phytotherapy and cooking. Globally recognized common names for C. officinalis encompass calendula, field marigold, garden marigold, poet's marigold, gold bloom, holligold, maravilla, marybud, marygold, pot marigold, rudders, Oculus Christi, Fiore d'ogni mese, Solis Sponsa, and Ringelblumen. Historically, Calendula was referred to as "golds" in Old English, initially linked to the Virgin Mary and subsequently to Queen Mary, resulting in the designation "Mary's gold" or marigold.(1)

Many different types of soil and sunny locations are ideal for growing *Calendula officinalis*. *Calendula officinalis* is a tall plant that features erect stems that are sparingly branching, rectangular lance leaflets with tubular disc florets, and a thorn-curving achene that is yellow or orange in color.(2)

The annual or biennial plant *Calendula officinalis* Linn., sometimes known as pot marigold, grows to a height of 30 to 60 cm. Many cultivated plants include margina flowers, bright yellow to orange flower heads, angular, hairy, and solid stems, lower spoon-shaped leaves that are 10–20 cm long and 1-4 cm broad, and the tallest oblong leaves that are 4–7 cm long.(2)

C. officinalis Linn., generally known as marigold, is grown extensively in temperate zones around the world. It is an erect, annual herb native to central, eastern, and southern Europe. It is widely cultivated in North America, the Balkans, Eastern Europe, Germany, and India. Calendula is a favourite among gardeners due to its prolific and lasting properties, which allow for cutting and floral arrangements. In India, the best period to plant is in April; flowering begins in June, and seeds ripen at the beginning August. Harvesting takes place between early and mid-August, and the plant continues to flower until the autumn frosts arrive. The plant grows to a height of 12-30 inches, depending on the type and culture. The leaves are brilliant green and normally measure approximately 4 inches long. The upper leaves are lance-shaped with pointy points, while the lower leaves are oval with rounded tips (spatulate). The flowers are usually 2-3 inches in diameter and are held on broad, robust stems. Calendulas are lovely flowers that can have one or two flowers and range in color from white to light yellow to orange, with some having a dark brown center. The taxonomic traits and vernacular names of the calendula are described here.(3,4)

Plant Profile:

Synonym: *Calendula aurantiaca* Kotschy ex Boiss.

Calendula eriocarpa DC.

Calendula hydruntina (Fiori) Lanza

Calendula prolifera Hort. ex Steud.

Caltha officinalis (L.) Moench

Botanical classification:(5)

Kingdom: Plantae

Subdivision: Tracheobionta

Division: Magnoliophyta

Class: Magnoliopsida

Orders: Asterales

Family: Asteraceae

Genus: Calendula

Species: *Calendula officinalis*

Common names:(5)

English: Calendula, Marigold, Pot marigold

Hindi: Zergul

Marathi: Jerbera

German: Butterblume

Chinese: Chin chan Ts'ao

Romanian: Galbinele

Swedish: Ringoblomma

Vernacular Names:(6)

- **Bihar: Genda**
- **Jammu and Kashmir: Sadberga**
- **Karnataka: Calendula**
- **Puducherry: Flower**

- **Punjab: Pimpa**
- **Sikkim: Calendula**

Traditional uses:

According to the Ayurvedic and Unani medical traditions, *Calendula officinalis* has therapeutic properties. Recent *Calendula officinalis* remedies include pot marigold tincture and caryophyllene ointment, which contains carotenoids extracted from the flowers. It is a component of the homeopathic medication used to treat acute musculoskeletal injuries, which helps to reduce oedema and pain. Calendula flower-based herbal ear drop formulations have shown promise in treating ear pain in kids with acute otitis media. Rich in therapeutic active components, *Calendula officinalis* promotes lymphatic and blood circulation, which helps the body rid itself of pollutants. been used historically as a diuretic and diaphoretic to treat convulsions, as well as for internal organ inflammations, gastrointestinal ulcers, and dysmenorrhea. Chronic ailments are treated with calendula infusion, a herb that is cleaning and purifying. The dried flower heads' cicatrising, antipyretic, and antitumor qualities have been employed. A topical application of flower infusion is used as an antifungal and antibacterial for wounds, marks, freckles, sprains, and conjunctivitis. In homeopathy, calendula tea is used as eyewashes, gargles, and for a variety of other skin and mucous membrane inflammatory conditions. *Calendula officinalis* tincture is used to relieve mental strain and insomnia. In both conventional and homeopathic medicine, *Calendula officinalis* has been used to treat duodenal ulcers, varicose veins, hemorrhoids, menstrual abnormalities, and vision impairment. In the Middle Ages, calendula flowers were used to cure snake bites, liver obstructions, and heart problems. In the past, it was used to treat jaundice, red eyes, and headaches. The herb has been utilized to treat jaundice, smallpox, measles, and wounds.(2,4)

Chemical Constituents:

Calendula officinalis flowers and leaves contain the following essential oils: α-pinene, α-ylangene, α-copaene, β-bourbonene, α-gurjunene, β-cubebene, β-caryophyllene, α-himachalene, (Z)-β-farnesene, α-humulene, γ-muurolene, γ-himachalene, germacrene D, α-muurolene, Bicyclogermacrene, δ-cadinene, γ-cadinene. Nonadecane, caryophyllene oxide, calamenene, epi-cubebol, neophytadiene, α-calacorene, palustrol, cubebol, γ-calacorene,

eicosane, tricosane, tetracosane, elemol, heneicosane, viridiflorol, hexahydrofarnesyl acetone, spathulenol, τ-cadinol, docasane, τ-muurolol, δ-cadinol, 1-methyl ethyl hexadecanoate, α-cadinol, tricosane, tetracosane,(7)

Carotenoids: carotenoids which are pre-eminently found in plant flowers, principally comprise of ly-copene, beta carotene, lutein, flavoxanthin, and zeaxanthin. Some of the additional carotenoidsfound inpetals and pollens of CO include luteoxanthin, neoxanthin, violaxanthin, 9Z-Violaxanthin,9Z-Neoxanthin, auroxanthin, 9Z-Anthroxanthin, mutatoxanthin, 13/130Z-Lutein,α-cryptoxanthin, z-cryptoxanthin, 9/90Z-lutein,α-carotene,β-carotene, andβ-cryptoxanthin. In addition to this, carotenoids identified in the stem and leaves of CO include violaxanthin,9Z-Violaxanthin, 9Z-Neoxanthin, antheraxanthin, neoxanthin, mutatoxanthin epimer 1 and 2, 9/90Z-Lutein, β-carotene, α-cryptoxanthin, lutein, luteoxanthin, β-cryptoxanthin, and13Z-Violaxanthin. Carotenoids are largely known for their antioxidant activity through a radical scavenging mechanism, which makes them particularly beneficial in thepharmacotherapy of oxidative diseases. The same antioxidant capability and their ability toform artificial cross-linkage make them possess wound-healing function. Zeaxanthin,a non-provitamin A carotenoid belonging to the xanthophyll family, is recognized to have abeneficiary therapeutic effect on age-related macular degeneration through its antioxidantand blue-filtering capabilities.(8–10)

Flavonoids:

Various flavonoids have been isolated from C. officinalis. They include quercetin, isorhamnetin, isoquercetin, isorhamnetin-3-O-β-D-glycoside, narcissin, calendoflaside. calendoflavobioside, rutin, calendoflavoside, isoquercitrin, neohesperidoside, neohesperidoside, isorhamnetin-3-O isorhamnetin-3-O-2G rhamnosyl rutinoside, isorhamnetin-3-O rutinoside, quercetin-3-O-glucoside quercetin-3-O-rutinoside(11,12)

Lipids:

C. officinalis seed oil contained D-(+)-9 hydroxy-10,12-octadecadienoic acid. Lauric, myristic, palmitic, stearic, oleic, linoleic, and linolenic acid were among the fatty acids of monols, sterol esters, 3-monoesters, and 3-monoester diols that were found in flowers.(13,14,15)

Amino Acids:

Alanine, arginine, aspartic acid, asparagine, valine, histidine, glutamic acid, leucine, lysine, proline, serine, tyrosine, threonine, methionine, and phenylalanine are among the 15 amino acids that we found in the free state in the leaves, stems, and flowers. It was determined that extracts from various plant components contained these amino acids in varying degrees of intensity. Using the intensities of the spot colors to determine the amino acids, we discovered that the leaves had roughly 5% of amino acids, the stems 3.5%, and the flowers 4.5%. The leaves, stems, and flowers were therefore abundant in free amino acids, as the results demonstrate. Argirtine, proline, glutamic acid, phenylalanine, lysine, and leucine were the six most prevalent among them.(16)

Pharmacological activities of *Calendula officinalis*:

1. **Antacid and antiulcer activity:**

The antiulcer activity is measured using various experimental models, including pylorus ligation-induced ulcers, indomethacin-induced ulcers, and 100% ethanol-induced ulcers. In all of these models, ranitidine is employed as a conventional medication at a dose of 50 mg/kg orally. *Calendula officinalis* ethanolic extract is given as the test medication at doses of 100mg/kg and 200mg/kg. In the pylorus ligation-induced ulceration, the 200 mg/kg dose inhibits 78.72%, while ranitidine inhibits 80.05%. Similarly, the test medication at 200 mg/kg exhibits 67.90% inhibition of indomethacin-induced ulcers, compared to the standard of 69.75%.(17)

2. **Anti-inflammatory activity:**

The macrophages stimulated by LPS are able to access the anti-inflammatory properties of calendula oil. The measurement of nitrate buildup in the culture media is used to analyze the impact of NO production. The results demonstrated a dose-dependent NO inhibition up to 50%, exhibiting a safety profile, thus, supporting the anti-inflammatory effect of calendula flower extract.(18)

3. **Anti-HIV Activity:**

To assess the cytotoxicity of the test extracts, the anti-HIV activity is measured. *Calendula officinalis* aqueous and organic extracts are assessed in this activity. HIV-infected cells were not significantly protected by the aqueous extract's inhibitory effects on HIV-l replication in acutely infected lymphocytic Molt-4 cells. However, the natural extract demonstrated remarkable efficacy, with the highest cytoprotection being noted at doses between 10 and 30 µg/ml.(19)

4. Antioxidant Activity:

In-vitro and in-vivo models are used to assess the antioxidant activity of *Calendula officinalis* flowers. In-vitro antioxidant activity is investigated utilizing superoxide radical scavenging activity, hydroxyl radical scavenging activity, lipid peroxidation inhibition, DPPH radical scavenging activity, ABTS radical scavenging activity, and nitric oxide radical scavenging activity. Table 1 shows the concentration required for 50% inhibition.(20–22)

Concentration needed for 50% inhibition (IC50)	
	***Calendula officinalis* extract**
Superoxide radical scavenging	500 µg/ml
Hydroxyl radical scavenging	480 µg/ml
Inhibition of lipid peroxidation	2000 µg/ml
DPPH radical scavenging	100 µg/ml
ABTS radical scavenging	6.5 µg/ml
Nitric oxide scavenging	575µg/ml

Table no. 1

5. Antidepressant activity:

Calendula officinalis ethanolic extract's antidepressant effects in Wistar rats are assessed using this approach. The immobility time in the Forced Swim Test (FST) and the number of squares crossing and rearing in the Open Field Test (OFT) were recorded in order to ascertain this effect. There were five groups of rats. Group 2 rats received imipramine (10 mg/kg, i.p.) as the standard group, whereas group 1 rats served as the control group. I.P. treatment was given to Wistar rats. Groups 3, 4, and 5 were administered 100 mg/kg, 200 mg/kg, and 400 mg/kg of *Calendula officinalis* ethanolic extract, respectively. *Calendula officinalis* ethanolic extract demonstrated a strong to moderate antidepressant effect, according to the results of a rat model of depression.(24)

6. Antiasthmatic activity:

The antiasthmatic study was studied by histamine and acetylcholine aerosol-induced bronchospasm in guinea pigs and by mast cell degranulation in rats. In the mast cell degranulation study, degranulation was observed which was not significant in the control group as compared in the standard group and the results are significant in the test group.(25)

7. Antinociceptive activity:

Calendula officinalis is widely used in traditional medicine as an anti-inflammatory agent. The present study was designed to evaluate the antinociceptive effect of hydro-alcoholic extract of *Calendula officinalis* in male rats. The animals were treated intraperitoneally with different doses of the *Calendula officinalis* flower extract (100, 150 and 250 mg/kg body weight). The analgesic activity was tested by tail flick and acetic acid-induced writhing tests. All doses of the extract significantly increased the tail flick latency compared to the control group.(26)

8. Antimicrobial Effects:

Methanol and ethanol extracts from Calendula petals has been tested for antibacterial activity against clinical pathogens, including bacteria and fungi such as Bacillus subtulis, Staphylococcus aureus, Escherichia coli, Klebsiella pneumonia, Candida albicans and Aspergillus niger. The methanol extract of *Calendula officinalis* showed better antibacterial activity than against most of the bacteria tested and was better than the ethanol extract. Both methanol and ethanol extract showed excellent antifungal activity against the fungal test strain.(27)

9. Anti-Tumour and Immunomodulatory Activities:

In this study, we evaluated the in vitro cytotoxic anti-tumor and immunomodulatory activities and in vivo anti-tumor effect of Laser Activated Calendula Extract (LACE), a novel extract of the plant *Calendula officinalis* (Asteraceae). Methods: An aqueous extract of *Calendula officinalis* was obtained by a novel extraction method in order to measure its anti-tumor and immunomodulatory activities in vitro. Tumor cell lines derived from leukemias, melanomas, fibrosarcomas and cancers of breast, prostate, cervix, lung, pancreas and colorectal were used and tumor cell proliferation in vitro was measured by BrdU incorporation and viable cell count. Effect of LACE on human peripheral blood lymphocyte (PBL) proliferation in vitro was also analyzed. Studies of cell cycle and apoptosis were performed in LACEtreated cells. In vivo anti-tumor activity was evaluated in nude mice bearing subcutaneously human Ando-2 melanoma cells. Results: The LACE extract showed a potent in vitro inhibition of tumor cell proliferation when tested on a wide variety of human and murine tumor cell lines. The inhibition ranged from 70 to 100%. Mechanisms of inhibition were identified as cell cycle arrest in G0/G1 phase and Caspase-3- induced apoptosis. Interestingly, the same extract showed an opposite effect when tested on PBLs and NKL cell line, in which in vitro induction of proliferation and activation of these cells was observed. The intraperitoneal injection or oral

administration of LACE extract in nude mice inhibits in vivo tumor growth of Ando-2 melanoma cells and prolongs the survival day of the mice. Conclusion: These results indicate that LACE aqueous extract has two complementary activities in vitro with potential anti-tumor therapeutic effect: cytotoxic tumor cell activity and lymphocyte activation. The LACE extract presented in vivo anti-tumoral activity in nude mice against tumor growth of Ando-2 melanoma cells.

10. Wound healing Activity

The ethanol extract of the plant's flowers was investigated against experimentally induced thermal burns in rats. Among the various extract doses (20, 100, and 200 mg/kg of body weight), the 200 mg/kg dose showed significant improvement in healing of wounds as indicated by increase in collagen hydroxyproline and hexosamine contents.(28)

Conclusion:

Calendula officinalis is found in a variety of herbal compositions that are used in clinical settings to treat a variety of diseases. The phytoconstituents of calendula species. *Calendula officinalis* appears to have a lot of potential for research into diverse biological processes. It can be found in a variety of forms including gel, cream, ointment, mouth washes, and systemic infusions. It is a very promising plant that needs in depth research and that can be used to extract active ingredients and to synthesise different drugs, to prevent various diseases, and also used to manage different pathologies. In this article, the botanical description, Traditional usage, pharmacological effects of *Calendula officinalis* were studied.

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