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A review of marigold's beneficial aspects

Sachin TM and Homraj Sahare

Abstract
The Asteraceae family, which includes Marigold, is the most widespread in the plant kingdom and is utilized in a variety of fields, including cosmetic preparations, medications, and ornamentals. It comes in a variety of colors and aromas. Through the extraction process, flowers are mostly utilized for these purposes. Health care requirements of people and societies have depended on medicinal plants. People in underdeveloped nations utilize a lot of herbal medicines that are produced from medicinal plants. It contains a highly fragrant essential oil (Tagetes oil), quercetagetin, a quercetagetin glucoside, phenolics, syringic acid, methyl-3, 5-dihydroxy-4-methoxy benzoate, quercetin, thienyl and ethyl gallate, terpines, and other significant phytochemical components from various parts of the plant. The leaves are said to be beneficial for piles, renal problems, muscle discomfort, ulcers, and wounds. The flower is used to treat fevers, epileptic fits (Ayurveda), astringent, carminative, stomachic, scabies, and liver problems, as well as eye disorders. These include antibacterial, antifungal, antioxidant, and hepatoprotective properties as well as wound healing and cytotoxic and insecticidal effects. As a result of this review, we have gained new knowledge into the benefits of *Tagetes erecta*.

Keywords: marigold, *Tagetes erecta*, medicines, essential oil

Introduction
Marigolds (*Tagetes* species) are one of the most significant and widely cultivated commercial flower crops on the world. Marigold is a member of the Asteraceae family and is native to South and Central America, particularly Mexico, where it is used in traditional medicine as well as for decorative purposes. There are more than 30 species of Tagetes (Asteraceae) in the genus Tagetes. The majority of the species in this genus are branching, annual or perennial herbs or shrubs used for horticulture and essential oil production (Singh *et al.*, 2016) [33]. Marigold is the most widely grown and produced loose flower in India, followed by chrysanthemum, jasmine, tuberose, and crossandra. Tagetes has a long history of human usage as drinks, sauces, ornamentals, and medical purposes such as analgesics, antiseptics, carminatives, diuretics, antispasmodics, anthelmintics, stimulants, vermin repellents, and treatment of stomach and intestinal disorders (Singh *et al.*, 2016) [33]. African marigold blooms have an appealing spectrum of colors for a long time and may be preserved in a remarkable condition when cut. The entire plant can sometimes be used as a decoration. They may be cultivated in pots, in beds for mass display, in mixed borders, and in mixed borders (Desai 1967) [10]. Marigold is becoming a more important commercial source of carotinoid pigments. The primary pigment in the flowers is xanthophyll, of which lutien accounts for 80 to 90% in the form of plamitic and myristic acid esters (Alam *et al.*, 1968) [2]. African marigold is commercially highly popular as loose flowers and has more application in garlands and decor. Marigold also use as trap crop in tomato field. The essential oil which is extracted by steam distillation is used in the perfumery industry, while extraction of xanthophylls is used in cosmetic and poultry food. Lutein is the major constituent about 80-90 per cent is present in the xanthophylls. Throughout the year, flowers are in high demand for various occasions, festivals, weddings, and floral decorating. Fever, epileptic fits, astringent, carminative, stomachache, scabies, and liver problems are all treated using different components of this plant, including the flower, in folk medicine. Leaves may also be used as an antiseptic, to treat renal problems, muscle discomfort, and boils and carbuncles (Kirtikar *et al.*, 1997).

Chemical constituents
Tagetes erecta contains quercetagetin, a glucoside of quercitin, as well as thienyl and ethyl gallate. Lutein is an oxycaroteniod or xanthophyll with two cyclic end groups (one one-ionone ring) and the fundamental C-40 isoprenoid structure that all cartenoids have in common.

It is a significant component and the primary pigment of *Tagetes erecta* (Ghani 1998) [14].

Twenty two natural occurring Phyto constituent including β-sitosterol, 7 hydroxy sitosterol, lupeol, erythrodiol, erythrodiol-3–palmitate, α-therthienyl, quercetagetin, quercetagetin-7-methyl ether, quercetagetin-7 O-glucoside, kaempferol, syringic acid, gallic acid, 3-β-galactosyldisyringic acid, 3-α- galactosyldisyringic acid, 6-ethoxy- 2,4-dimethyl quinoline, oplodiol, (3S,6R,7E)-hydroxy-4,7megastigmadien-9-one, palmitin, ethylene glycol lineate, and N- hexadecane various fraction of Ethanolic extract of flower of *Tagetes erecta* (Huang 2007) [17].

The steam distillation of fresh leaves offers 0.3% of essential with a strong, sweet lasting odour and contains d-limonene, llinalyl acetate, n-nonyl aldehyde, leutin. Six compounds were identified from the stem and leaves of *Tagetes erecta* plant as 4-methoxy-eupatolytin-3-O-glycoside, kaempferitrin, β-sitosterol, daucosterole and gallic acid (Zang and Zhang 2010) [43].

Steam distillation of fresh leaves yields 0.3 percent essential oil, which includes d-limonene, llinalyl acetate, n-nonyl aldehyde, and leutin and has a strong, pleasant, long-lasting odor. 4-methoxy-eupatolytin-3-O-glycoside, kaempferitrin, β-sitosterol, daucosterole, and gallic acid were discovered in the stem and leaves of *Tagetes erecta* (Zang and Zhang 2010) [43].

Antimicrobial Activity

Antimicrobial activity of flavonoids from *T. minuta* L. leaves has been reported, with the presence of quercetagetin-7-arabinosylgalactoside as the antimicrobial agent in the extract, as well as patuletin and patulitrin in certain fractions (Tereschuk *et al.,* 1997) [35].

Faizi *et al.* (2008)'s findings show that *Tagetes patula*, particularly its flavonoid-rich bloom, is an excellent source of antimicrobial agents. Patuletin (3), one of the easiest extractable and nontoxic flavonoids, showed antibacterial activity equivalent to its cinnammoyl derivative (3b).

The tincture made from its leaves and flowers, as well as its n-hexane, ethanol, and aqueous extracts, were evaluated for antibacterial activity against *Vibrio cholerae*, with the best antibiotic activity being recorded (Gupta and vasudeva, 2010) [16].

Insecticidal activity

T. patula has insecticidal components that may be beneficial as new insecticides against mirid or whitefly pests, according to (Fabrick *et al* 2020) [12]. Before commercialization, residual residues of marigold phytochemicals would need to be investigated for potential off-target effects on natural enemy and other beneficial arthropod communities, as well as unexpected health effects in human users (Desneux *et al.,* 2007) [11].

The aqueous and methanolic extracts of *Tagetes erecta* leaves, stem, and buds were found to have insecticidal action against the second stage larvae of *Tylenchulus semipenetrans* and *Anguina tritici* (kumari *et al.,* 1986) [23].

The essential oils of *Tagetes erecta* aerial parts exhibited significant cytotoxicity against *Artemia salina*, with an ED50 value of 3.16mg/mL. (De Feo *et al.,* 2005) [9]. Although Conboy *et al.* (2019) [8] shown that *T. patula* L. can act as a repellant companion plant against the whitefly *Trialeurodes vaporariorum* Westwood on tomatoes in greenhouses, it is uncertain what, if any, advantages might be obtained in lower-value crops and/or open field conditions.

Heptoprotective activity

According to Karwani and Sisodia (2015) [20], a hydoalcoholic extract of *Tagetes erecta* proved an efficient therapy for ethanol-induced hepatotoxicity. Biochemical markers such as serum transaminases, alkaline phosphatase, total protein, total cholesterol, bilirubin, and antioxidant characteristics were used to assess the level of protection. The ethanolic extracts demonstrated hepatoprotective efficacy equivalent to the conventional medication silymarin. According to the findings of this study, phenolic chemicals found in plant leaves may be responsible for the hepatoprotective effect. According to Vidyadhar and Sharma (2019) [39], the hepatoprotective properties of the plant may be related to the antioxidant principles of the plant, especially rutin11 and catechin18, as well as related flavonoids, tannins, and other polyphenoic chemicals. More research is needed to extract, identify, and screen the active principles from *Tagetes erecta* flowers that have antioxidant and hepatoprotective properties. Aithamraju Satish Chandra and Shanmugapandiyan (2021) [1] discovered that methanolic extracts of *Tagetes erecta* and *Tridax procumbens* may improve the protective effects of INH-RIF induced hepatotoxicity and DOX induced cardiotoxicity, respectively, by regulating marker enzymes, inhibiting lipid peroxidation, and improving antioxidant status.

Anti-bacterial Activity

For the antibacterial test, nutrient agar medium was employed, and inoculums were generated by inoculating 0.2ml of overnight cultures of each organism into 20ml of sterile nutrient broth and incubating at 37 °C for 3-5 hours to standardize the culture to yield 106 cfu/ml. The disc diffusion experiment was used to assess the antibacterial activity of the flavanoids (10 mg/100ml). The antibacterial activity of flavanoids (10 mg/100ml) was greater than that of the antibiotic tetracycline for all strains tested. *Klebsiella pneumonia* (29.50 mm) has the highest inhibition while Pseudomonas aeruginosa (21.00 mm) has the lowest (Bauer *et al.,* 1996).

The antibacterial activity of *Tagetes erecta* flower solvents was demonstrated against *Alcaligenes faecalis*, *Bacillus cereus*, *Campylobacter coli*, *Escherichia coli*, Klebisella pneumonia, and *Streptococcus pyogens*. Petulitrin, a flavonoid, is one of the probable components for its antibacterial action (Sharma *et al.,* 2011). According to Bissa and Bohra (2011) [4], plant extracts show significant potential as antibacterial agents against microorganisms and can be utilized in the treatment of infectious illnesses caused by resistant microbes.

Anti-oxidant Activity

Chivde *et al.,* (2011) [6] performed antioxidant investigations on the ethanolic extract of *Tagetes erecta* flowers using three distinct assays such as DPPH, reducing power, and super oxide radical scavenging activity at various doses. In all three assays, *Tagetes erecta* outperformed the standard (ascorbic acid) in terms of reducing power, but super oxide anion scavenging activity and DPPH antioxidant activity were lower. The essential oil of *Tagetes erecta* flowers shown anti-oxidant action in DPPH, thiocyanate, ß-carotene bleaching, free radical scavenging activity, and deoxyribose oxidation assays (Martha *et al.,* 2006).

Chkhikvishvili *et al.* (2016) [7] discovered for the first time that flavonoid and carotenoid components of French marigold (*Tagetes patula* L.) extract may protect Jurkat cells from

oxidative stress induced by hydrogen peroxide. These protective strategies may entail both direct radical-scavenging actions and activation of cellular antioxidant enzymes and anti-inflammatory molecules such as IL-10. The results support the antioxidant and anti-inflammatory effects of marigold preparations used in traditional medicine, which have been verified in animal and human research.

Mosquitocidal activity

Mosquitocidal effect of *Tagetes erecta* flower extracts in ethanol, chloroform, and petroleum ether against various strains of *Cx. quinquefasciatus*. Among the investigated materials, the chloroform soluble fraction had the greatest toxicity and LC_{50} values (14.14 g/mL, 1.706 g/mL, 36.88 g/mL, and 75 g/mL) for all instars of *Cx. quinquefasciatus* larvae. With increasing age and time, the larvae demonstrated comparative tolerance. They determined that the *Tagetes erecta* flower had high Mosquitocidal action (Rahman *et al*., 2009) [29]. Satoto *et al.* (2018) [30] revealed that essential oil of *Tagetes erecta* L. leaves at a concentration of 100% had mosquitocidal action against *Aedes aegypti* and *Culex quinquefasciatus* mosquitos, however the mosquitocidal activity was not superior to 13.16 g LG^1 prallethrin.

Wound healing activity

In albino mice, carbopol gels produced from hydro alcoholic extracts of *Gymnema sylvestere* (GE) and *Tagetes erecta Linn.* (TE) demonstrated wound healing efficacy in excision and burn wound models. In excision and burn wound models, the GE and TE treated animals shown a substantial decrease in the duration of epithelization and wound contraction, and the combined gel demonstrated faster wound healing activity, perhaps due to synergism. The increased wound healing activity of hydro alcoholic extracts may be attributed to free radical scavenging action and the phytoconstituents (flavonoids) contained in it, which either alone or in combination speed up the wound healing process (Kiranmai *et al.*, 2011) [21].

Treatment with *Tagetes erecta* hydro alcoholic extract has a positive effect on different phases of wound healing such as fibroplasias, collagen production, and wound contraction, resulting in quicker healing. The crude extract of *Tagetes erecta* substantially enhanced wound contraction, incision wound breaking strength, and dry granulation weight in the treatment group as compared to the extract of *Tagetes erecta* (Chatterjee *et al.*, 2011) [5].

According to Sultana *et al.*, (2021) [34], topical use of *Tagetes erecta* flower paste on surgical wounds in goats resulted in a considerably faster rate of wound healing and a shorter epithelialization time. The study found that flower petals had good wound healing capabilities, which might be ascribed to the individual or combined activity of phytoconstituents in the extract such as alkaloids and terpenoids.

Larvicidal activity

Perich *et al.* (1995) [27] demonstrated larvicidal activity of a-T, BBT, 59-methyl-BBT, and 5-methyl-a-T from *T. minuta* L. floral extract against *Aedes aegypti* and *Anopheles stephensi* larvae and adults. According to Marques *et al.* (2011) [25], *T. erecta* is a rich source of active chemicals with larvicidal action against the dengue vector. *T. erecta* essential oil might be used in the field by creating an emulsion with water and a surfactant, as has been done with other insecticidal essential oils.

The larvicidal thiophenes butenenylbithiophene (BBT) and alpha-terthienyl (a-T) were found in the roots and flowers of the plant, whereas hydroxybutenenylbithiophene and acetoxybutenenylbithiophene were found in all plant tissues. a-T revealed that in the presence of UV light, it becomes a powerful chemical against *Aedes aegypti* larvae, outperforming DDT and malathion (Arnason *et al.*, 1981) [3].

When compared to pure leaf or pure stem extract, the combined Marigold leaf and stem extract had better larvicidal efficacy and impact in killing mosquito larvae. It was also discovered that the 100 percent extract had a higher efficacy in destroying mosquito larvae.

Anti hyperlipedemic activity

The hepatoprotective effect of *Tagetes erecta* flowers was evaluated using a carbon tetrachloride-induced hepatopathy model. Serum ALT, AST, ALP, and bilirubin levels increased in CCL4-treated rats. When compared to the CCL4-intoxicated group, the ethyl acetate fraction of *Tagetes erecta* (EATE) at a dosage of 400 mg/kg orally dramatically reduced the elevated serum marker enzymes and bilirubin levels. Except for cytoplasmic vascular degenerations surrounding portal tracts, moderate inflammation, and foci of lobular inflammation, rats treated with 400 mg/kg of (EATE) extract and CCL4 exhibited a remarkable recovery. The observed hepatoprotective effect is attributed to phytoconstituents such as flavanoids, terpenoids, and steroids (Giri *et al.*, 2011) [15].

Anti-diabetic activity

Wang *et al.*, (2016) [42] observed at the anti-diabetic and antilipemic properties of quercetagetin, which was extracted from marigold (*Tagetes erecta* L.) inflorescence residues, with a focus on the inhibitory effects on -glucosidase, -amylase, and pancreatic lipase. Quercetagetin had a significant inhibitory impact on -glucosidase and pancreatic lipase, as well as a moderate inhibitory effect on -amylase. Furthermore, the results showed that quercetagetin has a high antioxidant capacity. In conclusion, the findings of this study provided critical scientific evidence for the use of quercetagetin as a nutraceutical in the treatment of diabetes and obesity.

Lutein extract from marigold flowers was evaluated for its potential as an anti-diabetic and antioxidant in S. Mice of the Dawley strain. The decrease in blood sugar levels was seen in male white mice with hyperglycemia, which corresponded to an increase in the lutein dosage of 40, 80, and 160 mg/kgBB. The ability of lutein to act as an antioxidant was demonstrated by a reduction in malondialdehyde (MDA) levels in the blood of mice caused by alloxan. The higher the lutein dose, the greater the inhibition of lipid peroxidation processes. The decrease in MDA levels in the blood corresponded to an increase in lutein dosages supplied (Kusmiati *et al.*, 2019) [24].

Raghuveer *et al.* (2011) [28] investigated the anti-diabetic efficacy of a hydroalcoholic extract of *Tagetes erecta* by inducing diabetes with a single intra-peritoneal injection of streptozotocin (60 mg/kg b.w.). Blood glucose levels climbed after 30 minutes of treatment with the usual medication Glibenclamide, followed by a subsequent decrease lasting up to 120 minutes. According to the findings of the current investigation, injection of *Tagetes erecta* extracts resulted in a rise in glucose levels after 30 minutes and a hypoglycemic impact after 120 minutes.

Cytotoxic activity

Chkhikvishvili *et al.* (2016) [7] discovered that certain *T. patula* flavonoids, particularly patuletin, can exhibit cytotoxic effects on Jurkat cells, signifying anticancer activity. The transition from cytoprotective to cytotoxic action is determined by the concentration and chemical composition of the component. The *Tagetes* species had previously been reported to exhibit cytotoxic action, as aqueous and ethanol extracts of *T. lucida* aerial parts were effective against HeLa (GI50: 13.2 g/ml and GI50: >50 g/ml) and breast cancer (T47D) cell lines (GI50: 18.9 g/ml and GI50: 1.82 g/ml, respectively) (Vega-Avila *et al.*, 2009) [37].

The bioassay-guided activity of a methanol extract of *T. patula* flower resulted in the isolation of patuletin (2), a major flavonoid known for its cytotoxic and growth inhibitory properties, particularly against cervical cancer (HeLa cell line). Its glucoside, patulitrin (3), and phenolic acid, methyl protocatechuate (1) both inhibited growth. One proposed mechanism for their growth inhibitory or cytotoxic effects appears to be connected to their antioxidant characteristics.

The dry ethanolic extract shown strong cytotoxic activity with an LC_{50} of 35.568 g/mL, whereas the dry aqueous extract at 20% demonstrated moderate cytotoxic activity with an LC_{50} of 386.048 g/mL (Velásquez *et al.*, 2020) [38].

Anti-epileptic activity

In vivo models such as pentobarbitone-induced sleeping duration, MES and PTZ-induced convulsions, potentiation of PTZ-induced convulsion, spontaneous locomotor activity, forced swim test, and learned helplessness test model were used to assess the ethanolic extract *Tagetes erecta*. *Tagetes erecta* ethanolic extract shown antiepileptic efficacy. The data showed that ethanolic extract may lower the seizure threshold in epileptic patients, but the risks of seizure precipitation are increased, therefore use in epilepsy is advised with caution (Shetty *et al*., 2009) [32].

Anti-inflammatory activity

Linalool and linalool-rich essential oils are known to have a variety of biological activities, including antibacterial, anti-inflammatory, anticancer, and antioxidant effects, according to Kamatou and Viljoen (2008) [19]. Injecting 0.1ml of 1% Carrageenan into the plantar area of a rat hind paw caused acute inflammation. The extract (100, 200, and 400mg/kg, orally) and phenylbutazone (PBZ, 100mg/kg, orally) were given 60 minutes before the carrageenan injection. The paw volume was measured pethysmometrically at 0, 0.5, 1, 2, 3, and 4. The extract, when taken orally, greatly decreases the discomfort caused by the acetic acid writhing reaction. The amount of writhing reflexes decreased substantially in treated mice and was equivalent to ASA. There was no discernible difference in thermal stimuli (Vogel 2002).

Nematocidal activity

The nematicidal efficacy of four medicinal plants, *Azadirachta indica*, *Calotropis procera*, *Datura stramonium*, and *Tagetes erecta*, for the control of M. incognita, was determined by Husain *et al.*, 2011 [18]. In comparison to the untreated control, all leaf amendments at various dosages improved okra plant growth characteristics and reduced root-knot infections. Wang *et al.* (2007) [41] conducted research on marigold's nematocidal properties. This plant generates a variety of possibly beneficial chemicals, the most poisonous of which is therthienyl. This sulfur-containing chemical is found in high concentrations in marigold tissues, especially roots. It contains nematicidal, insecticidal, fungicidal, antiviral, and cytotoxic properties, and it is considered to be the primary component responsible for marigold's nematicidal action. Nematicidal chemicals appear to infiltrate marigold root tissues into nematodes connected to the root, but they are also thought to kill nematodes located in the rhizosphere, the soil around marigold roots. As a result, marigold is thought to be the most efficient in controlling plant-parasitic nematodes.

Traditional uses

Various components of the *Tagetes erecta* plant, particularly the flower, are used in traditional medicine to treat a variety of illnesses. The leaves of this plant are used as an antiseptic, to treat renal problems, muscle discomfort, piles, and to treat boils and carbuncles. The flower petals are used to treat fevers, epileptic fits (Ayurveda), astringent, carminative, stomachic, scabies, and liver problems, as well as eye disorders. They are supposed to cleanse the blood, and flower juice is used to treat bleeding piles as well as rheumatism, colds, and bronchitis (Shetty *et al.*, 2009; Vallisuta *et al.*, 2014) [32, 36].

Conclusion

Many Indian plants are utilized in traditional Indian medicine to treat a variety of human diseases. *Tagetes erecta* is a popular anti-inflammatory medicinal plant that may also be used to treat wounds, cancer, liver disease, and diabetes. Furthermore, in the future, the isolated principles from *Tagetes erecta* should be evaluated scientifically using various innovative experimental models and clinical trials to understand its mechanism of action and to search for other active constituents, so that its other therapeutic uses can be widely explored. As a result, *Tagetes erecta* can be regarded as a treatment for a variety of illnesses and should be researched further.

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