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Review article

Tagetes erecta (Marigold) - A review on its phytochemical and medicinal properties

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ABSTRACT

Medicinal plants extract and secondary metabolites are becoming popular all over the world as a natural alternative to synthetically produced chemicals both in Traditional and Allopathic system of medicine. This article discusses the medicinal values of *Tagetes erecta* (Compositae), also known as Genda Phul (marigold), reported during the period between 2006 and 2014. Different parts of the plant are useful in fevers, astringent, carminative, stomachic, scabies and liver complaints, diseases of the eyes, purify the blood, bleeding piles, rheumatism, colds and bronchitis. The plant *Tagetes erecta* contains various important phytochemical constituents from the different part of the plant. It shows different pharmacological activities like anti-nociceptive, anti-inflammatory, antioxidant, insecticidal, larvicidal, hepatoprotective, antipyretic, wound healing, antibacterial, antimicrobial, antiepileptic and antifungal. This review discusses the investigation made by various workers related to chemical constituents, pharmacological action and toxicological studies, traditional and non-pharmacological uses of this plant for years.

INTRODUCTION

Natural plant products have been used throughout human history for various purposes. Many of these natural products have biological activity that can involve in drug discovery and drug design. The Indian system of medicine known as ‘‘Ayurveda’’ uses mainly plant-based drugs or formulations to treat various ailments, including cancer. Herbal drugs have great growth potential in the global market. Research work on the chemistry of natural products, pharmacognosy, pharmaceutics, pharmacology and clinical therapeutics have been carried out on herbal drugs and most of the leading Pharmaceutical corporations have revised their strategies in favour of natural products. Many herbal remedies individually or in combination have been recommended in various medical treatises for the cure of different diseases. The therapeutic value of *Tagetes erecta,* commonly known as Marigold, has been recognized in different systems of traditional medicine for the treatment of different human ailments (Dixit et al., 2013).

Tagetes is a genus (family Compositae/ Asteraceae) containing about 50 species of annual or perennial herbaceous plant. The plant *Tagetes erecta* L. (Fig. 1) is locally known as Genda Phool (Marigold). Marigold is a spice native to India. Historically, marigold has been used all over India, China and Indonesia as a spice and medicinal agent. Marigold is a spice that enhances the flavour of foods and is the base of most Indian curries. Marigold is used in curries goes back more than 5000 years. It is stout, branching herb, native to Mexico and other warmer parts of America and neutralized elsewhere in the tropics and subtropics including India and Bangladesh. These are rapid-growing annual flowering plants in height ranging from dwarfs of 6-8 inch, to medium and taller and erect-growing plants with heights from 10 into 3ft, bearing large pompon-like double flower up to 5 in across and has a shorter flowering period from midsummer to frost. It is very popular as a garden plant and yields a strongly aromatic essential oil (Tagetes oil), which is mainly used for the compounding of high-grade perfumes. It is very popular as a garden plant and yields a strongly aromatic essential oil (Tagetes oil), which is mainly used for the compounding of high-grade perfumes. Different parts of this plant including flowers are used in folk medicine to cure various diseases. Leaves are used as antiseptic and in kidney troubles, muscular pain, piles and applied to boils

and carbuncles. The flower is useful in fevers, epileptic fits (Ayurveda), astringent, carminative, stomachic, scabies and liver complaints and is also employed in diseases of the eyes (Ampai et al., 2013).

Fig. 1. The whole plant of marigold together with blooming flowers

TAXONOMICAL CLASSIFICATION

Tagetes erecta is stout, branching herb, native to Mexico and other warmer parts of America and neutralized elsewhere in the tropics and subtropics including India and Bangladesh.

Kingdom	:	Plantae
Order	:	Asterales
Family	:	Asteraceae
Subfamily	:	Asteroideae
Class	:	Magnoliopsida
Division	:	Magnoliophyta
Genus	:	*Tagetes*
Species	:	*erecta*

VERNACULAR NAMES

Language	Name	Language	Name
Marathi	Zendu	Sanskrit	Sandu
Hindi	Genda	Punjabi	Tangla
Bengali	Genda	Malayalam	Chendumalli
Gujarati	Guliharo	Telugu	Bantichettu
Manipuri	Sanarei	Urdu	Genda
Konkani	Gondi-phool	Kannada	Chenna mallige

OTHER IMPORTANT SPECIES OF *TAGETES*

Marigold (*Tagetes erecta*) is a flower, which is native to tropical South Asia. As many species of *Tagetes* have been identified worldwide (The Plant List, 2013). These are summarised in Table 1.

Table 1. Different species of the genus *Tagetes*

S.No.	Accepted species
1.	*Tagetes apetala* Posada-Ar.
2.	*Tagetes arenicola* Panero & Villaseñor
3.	*Tagetes argentina* Cabrera
4.	*Tagetes biflora* Cabrera
5.	*Tagetes campanulata* Griseb.
6.	*Tagetes caracasana* Humb. ex Willd.
7.	*Tagetes congesta* Hook. & Arn.
8.	*Tagetes coronopifolia* Willd.
9.	*Tagetes daucoides* Schrad.
10.	*Tagetes elliptica* Sm.
11.	*Tagetes elongata* Willd.
12.	*Tagetes epapposa* B.L.Turner
13.	*Tagetes erecta* L.
14.	*Tagetes filifolia* Lag.
15.	*Tagetes foeniculacea* Desf.
16.	*Tagetes foetidissima* Hort. ex DC.
17.	*Tagetes hartwegii* Greenm.
18.	*Tagetes iltisiana* H.Rob.
19.	*Tagetes inclusa* Muschl.
20.	*Tagetes lacera* Brandegee
21.	*Tagetes laxa* Cabrera
22.	*Tagetes lemmonii* A.Gray
23.	*Tagetes linifolia* Seaton
24.	*Tagetes lucida* Cav.
25.	*Tagetes lunulata* Ortega
26.	*Tagetes mandonii* Sch.Bip. ex Klatt
27.	*Tagetes mendocina* Phil.
28.	*Tagetes micrantha* Cav.
29.	*Tagetes microglossa* Benth.
30.	*Tagetes minima* L.
31.	*Tagetes minuta* L.
32.	*Tagetes moorei* H.Rob.
33.	*Tagetes mulleri* S.F.Blake
34.	*Tagetes multiflora* Kunth
35.	*Tagetes nelsonii* Greenm.
36.	*Tagetes oaxacana* B.L.Turner
37.	*Tagetes osteni* Hicken
38.	*Tagetes palmeri* A.Gray
39.	*Tagetes parryi* A.Gray
40.	*Tagetes perezi* Cabrera
41.	*Tagetes praetermissa* (Strother) H.Rob.
42.	*Tagetes pringlei* S.Watson
43.	*Tagetes pusilla* Kunth
44.	*Tagetes riojana* M.Ferraro
45.	*Tagetes rupestris* Cabrera

46.	*Tagetes stenophylla* B.L.Rob.
47.	*Tagetes subulata* Cerv.
48.	*Tagetes subvillosa* Lag.
49.	*Tagetes tenuifolia* Cav.
50.	*Tagetes terniflora* Kunth
51.	*Tagetes triradiata* Greenm.
52.	*Tagetes verticillata* Lag. & Rodr.
53.	*Tagetes zypaquirensis* Bonpl.

CULTIVATION AND ECONOMICAL VALUE

Tagetes erecta is also known as "Marigold Flowers". Flowers are edible and also used as colouring agent and condiment. A yellow dye obtained from the flower can be used as a saffron substitute for colouring and flavouring foods. This probably refers to the use of the flowers as an edible dye.

Marigold is a hardy annual herb native to Southern Europe, which can also be found growing in most temperate regions of the world. They grow up to 50-80 cm in height, the leaves mid-green, lanceolate and between 5 and 17 cm in length. The leaves and stems are covered with small hairs; the edges of the leaf can be sparsely toothed or wavy. The plant grows to a height of one to five feet and is cultivated extensively in Asia, India, China, and other countries with a tropical climate. The marigold plant needs temperatures between 20°C and 30°C and a considerable amount of annual winter and rainfall to thrive.

The world production of marigold stands at around 600000 tones, of which India has a share of approximately 75-80%. India consumes about 80% of its own Production. Indian marigold is considered the best in the world. India exports marigold flower to discerning countries like Japan, Sri Lanka, Iran, North African countries, US and UK. The production of marigold is concentrated in the southern part of the country, mainly in the peninsula area. Andhra Pradesh, Utter Pradesh is the leading marigold producing state in India followed by Tamil Nadu. Andhra Pradesh also has the highest area under marigold cultivation. Maximum area under marigold is in Andhra Pradesh followed by Maharashtra, Tamil Nadu, Orissa, Karnataka, U.P and Kerala. The genus *Tagetes* contains many taxes which are economically important as food, condiment and as colouring, medicinal and ornamental materials. The highest diversity is concentrated in India and Thailand, with at least 50 species in each area, followed by French, Africa, Mexico, Myanmar, Bangladesh, Indonesia and India.

Tagetes erecta is the main species of commerce and distributed its flower in India, China and also in Shri Lanka, Indonesia, Jamaica and Peru. Erode, a city in the South Indian state of Tamil Nadu is India's largest producer and the most important trading centre for marigold (Majumder et al., 2014). The optimum time for cultivation and harvesting of marigold is given in Table 2.

Table 2. The optimum time for cultivation and harvesting of marigold

Season	Sowing time	Transplanting time	Harvesting time
Rainy	June-July	July-Aug	September-October, even up to December
Winter	September-October	October-November	November-December
Summer	January	February	March-April

CHEMICAL CONSTITUENTS

Phytochemical studies of its different parts have resulted in the isolation of various chemical constituents such as thiophenes, flavonoids, carotenoids and triterpenoids. The plant *T. erecta* has been shown to contain quercetagetin, a glucoside of quercetagetin, phenolics, syringic acid, methyl-3, 5-dihydroxy-4- methoxy benzoate, quercetin, vinyl and ethyl gallate. Lutein is an oxycarotenoid, or xanthophyll, containing 2 cyclic end groups (one beta and one alpha-ionone ring) and the basic C-40 isoprenoid structure common to all carotenoids. It is one of the major constituents and the main pigment of *Tagetes erecta* (Dixit et al., 2013).

The flower consists of carotenoids consisting of lutein, zeaxanthin, neoxanthin plus violaxanthin, β-carotene, lycopene, α-Cryptoxanthin, phytoene and phytofluene.

Li-Wei (2011) report the results of a thorough phytochemical study on 22 compounds from the flowers of *T. erecta* by isolation of various fractions of the ethanol extract by silica gel column chromatography. They were β-sitosterol, daucosterol, 7β-hydroxysitosterol, erythrodiol-3-palmitate, lupeol, erythrodiol, 1-[5-(1-propyn-1-yl)-[2, 2-bithiophen]-5-yl]-ethanone, α-terthienyl, quercetagetin, quercetagetin-7-methylether, quercetagetin-7-O-glucoside, kaempferol, syringic acid, gallic acid, 3-α-galactosyl disyringic acid, 3-β-galactosyl disyringic acid, 6-ethoxy-2, 4-dimethylquinoline, oplodiol, (3*S*, 6R, 7E)-hydroxy-4,7-megastigmadien-9-one, palmitin, ethylene glycollinoleate, and *n*-hexadecane. The chemical structures of lutein, quercetagetin and syringic acid are given in Fig. 2.

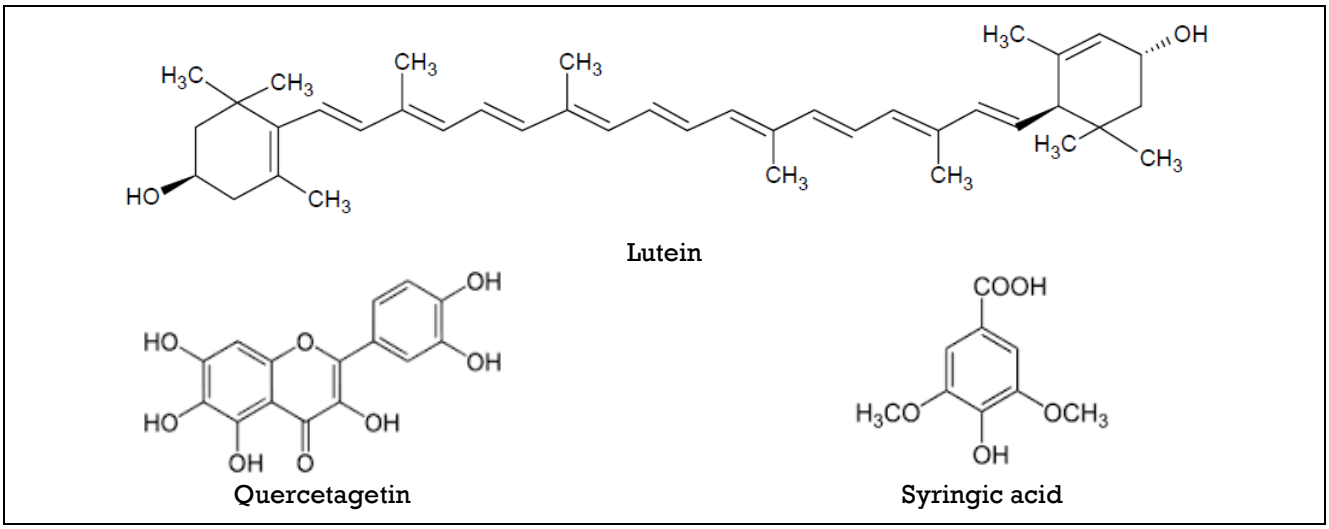

Fig. 2. Major chemical constituents of *Tagetes erecta*

PHARMACOLOGICAL ACTIVITIES

Tagetes erecta shows diverse pharmacological activities which are shown below in the following heads.

Antibacterial activity

The antibacterial activity of different solvents of *Tagetes erecta* flowers against *Alcaligens faecalis, Bacillus cereus, Campylobacter coli, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Proteus vulgaris, Streptococcus mutans* and *Streptococcus pyogenes.* The flavonoid possesses antibacterial activity against all the tested strains and shows a maximum zone of inhibition for *Klebsiella pneumoniae* (29.50 mm). Flavonoid-patulitrin is one of the potential elements for its anti-bacterial activity (Rhama and Madhavan, 2011). The flower parts showed maximum inhibitory action against *Neisseria gonorrhoeae* strain (Patrick et al., 2011).

Antinociceptive and anti-inflammatory activity

Antinociceptive and anti-inflammatory activity of chloroform, methanol and ether fraction of *Tagetes erecta* reported by using acetic acid-induced writhing in mice and carrageenan-induced paw oedema in the rat (Shinde et al., 2009). Anti-nociceptive and anti-inflammatory activity of hydroalcoholic extract of leaves of *Tagetes erecta* reported by using acetic acid-induced writhing and hot plate method in *mice* and carrageenan-induced paw oedema in the rat (Chatterjee et al., 2009).

Anti-oxidant activity

The ethanolic extract of *Tagetes erecta* flowers showed anti-oxidant activity by three different assays like DPPH, reducing power and superoxide radical scavenging activity at different concentrations were used. In all the three assays, *Tagetes erecta* showed better reducing power than the standard (i.e. ascorbic acid), and superoxide anion scavenging activity and DPPH antioxidant activity showed less than standard (Chivde et al., 2011). The essential oil of flowers of *Tagetes erecta* produced anti-oxidant activity by using DPPH, thiocyanate, ß-carotene bleaching, free radical scavenging activity and oxidation of deoxyribose assay (Martha et al., 2006).

Hepatoprotective activity

Ethyl acetate fraction of *T. erecta* at the dose of 400 mg/kg orally significantly decreased the elevated serum ALT, AST, ALP and level of bilirubin almost to the normal level compared to CCl_4-intoxicated group. Histological changes in the liver of rats treated with 400 mg/kg of the extract and CCl_4 showed a significant recovery except for cytoplasmic vascular degenerations around portal tracts, mild inflammation and foci of lobular inflammation (Giri et al., 2011).

Anti-cancer activity

Marigold has long been used as a medicinal herb for a number of therapeutic activities. The cytotoxic activity of ethanol and ethyl acetate extracts of marigold flowers and their inhibitory effects on elastase and tyrosinase enzymes were investigated. An assay was performed to measure the cytotoxicity of these two extracts on the H460 lung cancer and the $CaCO_2$ colon cancer cell lines (Vallisuta et al., 2014).

Antiepileptic activity

The ethanolic extract *Tagetes erecta* was evaluated using the *in vivo* models such as pentobarbitone induced sleeping time, MES and PTZ induced convulsions, potentiation of PTZ induced convulsion, spontaneous locomotor activity, forced swim test and learned helplessness

test model. The ethanolic extract *Tagetes erecta* showed antiepileptic activity. The findings suggested that ethanolic extract may reduce the seizure threshold in epileptic patients, chances of seizure precipitation is more, thus usage in epilepsy is cautious (Shetty et al., 2009).

Anti-diabetic activity

Hydro-alcoholic extract of *Tagetes erecta* was studied for its anti-diabetic activity. Diabetes was induced by a single intraperitoneal injection of streptozotocin (60 mg/kg b.w). Treatment with standard drug glibenclamide, blood glucose raised at 30 min followed by subsequent fall up to 120 min. It was observed that the administration of *Tagetes erecta* extracts increased the glucose levels were seen after 30 min and the hypoglycemic effect was observed only after 120 min (Rodda et al., 2011).

Anti-depressant activity

Tagetes erecta, the marigold, showed some anti-depressant activity. Some study was carried out to elucidate the antidepressant effect of hydromethanolic flower extract of *T. erecta*. The extract was evaluated for antidepressant effect using a forced swim test in mice. *T. erecta* significantly inhibited the immobility period in forced swim test in mice. (Khulbe et al., 2013).

Wound healing activity

The activities of the marigold extract on the wound healing of albino Wister rats have been evaluated. Thirty-six male and female rats weighing 150-200g were randomly selected and divided into 4 groups (A, B, C, and D). The test rats were fed normal rat feed and water ad libitum in addition to oral administration of 1.0ml of the petal extract of marigold. Blood samples were obtained by cardiac puncture of the animals into EDTA bottles for analysis. The initial blood picture of the animals was taken before administration of the extracts to the test rats. Results showed that *Tagetes erecta* extract increased platelet count, white blood cell count ($p>0.05$) and shortened the bleeding and clotting times (Oguwike et al., 2013). To screen the wound healing activity of carbopol gels prepared from hydroalcoholic extracts of *Gymnema sylvestere and Tagetes erecta* in excision wound model and burn wound models in albino mice. Formulations of the extracts were done in the form of gels of carbopol individually and also in combination in equal ratio. In excision and burn wound models, the so treated animals showed a significant reduction in the period of epithelization and wound contraction and combined gel showed accelerated wound healing activity may be because of synergism (Ibrahim et al., 2011).

Mosquitocidal activity

Mosquitocidal effects of ethanolic extract of flowers of *Tagetes erecta* and its chloroform and petroleum ether soluble fractions against the larvae of *Culex quinquefasciatus* have been investigated. The larvicidal effect of ethanol extract and their solvent fractions were determined by the standard procedure of WHO against different instars of *C. Quinquefasciatus* (Nikkon et al., 2011).

Anti-fungal activity

Fungitoxic activity of the essential oil of leaves of *Tagetes erecta* exhibited complete inhibition of the growth *Pythium aphanidermatum,* the damping-off pathogen, at a concentration of 2000 ppm (Kishore et al., 2006).

NON-PHARMACOLOGICAL IMPORTANCE

Studies reported that *Tagetes erecta* exhibited insecticidal (Sarin, 2004; Nikkon et al., 2009), larvicidal (Marcia et al., 2011), mosquitocidal (Nikkon et al., 2011) and nematicidal activity (Patrick et al., 2011). *Tagetes erecta* flower extract was found to contain biologically useful lutein compounds and studied for use as a nutritional supplement and as poultry food colourant (Leigh, 1999). The flower petals yield a natural dye, the colourants consisting mainly of carotenoid-lutein and flavonoid-patuletin, with crude extracts used for dyeing textiles. The study describes an innovative dyeing process with a net enhancement of dye uptake due to metal mordanting. Results suggest a potential for industrial application (Padma et al., 2009).

TRADITIONAL USES

Different parts of *Tagetes erecta* plant including flower are used as a traditional medicine to cure various diseases. Leaves of this plant are used as antiseptic, in kidney troubles, muscular pain, piles and applied to boils and carbuncles. The flower petals are useful in fevers, epileptic fits (Ayurveda), astringent, carminative, stomachic, scabies and liver complaints and is also employed in diseases of the eyes. They are said to purify the blood and flower juice is given as a remedy for bleeding piles and also used in rheumatism, colds and bronchitis (Shetty et al., 2009; Vallisuta et al., 2014). Different species of *Tagetes* have been found to possess antimicrobial, anti-inflammatory, hepatoprotective, wound healing, insecticidal, analgesic activities (Rodda et al., 2011; Ibrahim et al., 2011; Khulbe et al., 2013). The pharmacological activity of *Tagetes erecta* is related to the content of several secondary metabolites and the most important compounds are terpenes, essential oils, flavonoids, carotenoids and polyphenols (Kishore and Dwivedi, 2006; Nikkon et al., 2011).

CONCLUSION

The literature survey represented that the *Tagetes erecta* is an important medicinal plant with the diverse pharmacological spectrum and medicinally important phytoconstituents. *Tagetes erecta* shows the presence of many chemical constituents which are responsible for various medicinal properties, which can be used for the welfare of mankind. There are many other traditional uses of *Tagetes erecta* species in different traditional system, which serves as the basis for further studies. This review will definitely help the researchers to explore its different properties and interactions of *Tagetes erecta* plant.

CONFLICT OF INTEREST

Authors declare no conflicts of interest.

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