A Review on Pharmacological aspects of *Tagetes erecta Linn*

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ABSTRACT

Medicinal plants and derived medicine are widely used in traditional culture all over the world and they are becoming increasingly popular in modern society as natural alternatives to synthetic chemicals. Tagetes erecta Linn Known as "genda phool" (Marigold) belong to the family Astraceae, native to Mexico, Central America, Bolivia and Colombia. All parts of this plant used for medicinal purposes. It contained wide range of chemical constituents thiophenes, flavanoids, cartenoids, triterpenoids, oxycaroteniod and xanthophylls. This review article focus on the pharmacological actions like antibacterial, antifungal, antioxidant, hepatoprotective activity, wound healing property, cytotoxic and insecticidal activities. This review is a step to open insight for therapeutic efficacy of Tagetes erecta.

Keywords: Tagetes erecta Linn, Quercetagetin, Hepatoprotective, Anti-diabetic, Marketed Preparations.

INTRODUCTION

Medicinal plants are considered as rich resources of ingredient which can be used in the drug development either phamacopoeial, non pharmacopoeial or synthetic drugs (Faizi et al., 2004). The name marigold is however indiscriminately applied to several genera of composite with golden or yellow capitula and there are about 33 species of the genus Tagetes, out of which, five species have been introduced into the Indian gardens viz. (Tagetes glandulifera schrank), Tagetes patula L. (French marigold) and Tagetes lucida (Sweet-Scented Marigold), Tagetes tenulifolia (striped Marigold) (Kokate 2005). Different parts of this plants including flower are used in folk medicine to cure various diseases such as fever, epileptic fits, astringent, carminative, stomachache, scabies, and liver complaints. Leaves are also used as antiseptic, in kidney troubles, muscular pain and applied to boils and carbuncles (Kirtikar et al., 1997). Infusion of plant is used against rheumatism, cold and bronchitis (Sharma et al., 2007).

The plant Tagetes erecta has been shown to contain quercetagetin, phenolic, syringic acid, methyl-3, 5-dihydroxy-4-methoxy benzoate, quercitin, thienyl and ethyl gallate (Ghani 1998). Ethanolic extract of *T. Erecta* reported to possess central nervous stimulants and antidepressant property through serotonergic pathway may decrease the seizure threshold if used in epileptic patients. The essential oil also acts as anti haemorrhagic, anti-inflammatory, antiseptic, antispasmodic, astringent and is useful in aromatherapy for its powerful skin healings properties (Shiva et al., 2002).

Scientific Classification (George, 2010)

Kingdom	: Plantae
Subkingdom	: Tracheobionta
Division	: Magnoliophyta
Class	: Magnoliopsida
Subclass	: Asteridae
Order	: Asterales
Family	: Asteraceae
Genus	: Tagetes
Species	: erecta

Vernacular Names (Shetty et al., 2015)

English	: marigold or saffron marigold
Chinese	: wan shou ju
French	: tagète rose d'Inde
German	: hohe Studentenblume
Japanese	: senju-giku
Korean	: cheonsugug
Portuguese	: maravilha
Spanish	: flor de muerto
Hindi	: Gainda Phool

Plant Description

Marigold is a common garden plant which is rather coarse, erect, branched and grows to about 1 meter high. However there is short or dwarf varieties as well. The leaves are very deeply incised and sharply toothed. Flower heads are solitary, long stalked and thickening upward. The flowers are bright yellow, brownish-yellow or orange (Karwani and Sisodia, 2015).

Chemical Constituents

The plants *T. Erecta* has been shown to contain quercetagetin, a glucoside of quercitin, thienyl and ethyl gallate. Lutein is an oxycaroteniod or xanthophylls containing 2 cyclic end groups (one β one α- ionone ring) and the basic C-40 isoprenoid structure common to all cartenoids. It is one of the major constituent and the main pigment of *Tagetes erecta* (Ghani 1998).

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-4,7-megastigmadien-9-one, palmitin, ethylene glycol lineate, and N- hexadecane various fraction of Ethanolic extract of flower of *Tagetes erecta* (Huang 2007).

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).

PHARMACOLOGICAL ACTIONS

Antimicrobial Activity

The essential oil of the leaves and stems of *Tagetes erecta* showed noticeable antimicrobial activity against four gram positive and fifteen gram negative pathogenic bacteria (*Staphylococcus aureus, Bacillus mycoides, Bacillus pumilus, Bacillus subtilis, Salmonella paratyphi A, Salmonella paratyphi B, Salmonella paratyphi C, Salmonella typhi H, Salmonella enteritides, Salmonella flexneri, Salmonella typhimurium, Shigella sonnei, Shigella schimizii, Shigella shigae, Vibrio cholerae Inawa, Vibrio cholerae Ogawa, Vibrio cholera Eltor and Xanthomonas campestris*) strains with minimum inhibitory concentration (MIC) for the extract ranging between 12.5-100 µg/mL. The tincture prepared from its leaves and flower and its n-hexane, ethanol and aqueous extract were tested for inhibitory effect against *Vibrio cholerae* whereby it was reported that the best antimicrobial activity (Gupta and vasudeva, 2010).

A 0.2% concentration of marigold oil emulsion was reported for its significant fungicidal action against citrus fruit pathogen viz. *penicillum digitatum, Diplodia natalensis, penicillum Italicum* and *Alternaria tenuis* (Arora *et al.,* 1984).

Insecticidal Activity

The petroleum ether extract of the roots of *Tagetes erecta* exhibited toxicity against the third stage mosquito larvae of *Culex fatigens* (Singh and kataria, 1985). The aqueous and methanolic extract of leaves, stem and buds of *Tagetes erecta* reported for insecticidal activity against the second stage larvae of *Tylenchulus semipenetrans* and *Anguina tritici* (kumari *et al.,* 1986).

The essential oil from the fresh and dried plant of *Tagetes erecta* were reported to be highly effective against the larvae of *Anopheles stephensi* with the LC50 values of 1.0532 and 1.0314 mg/L (Hadjiakhoondi *et al.,* 2008) . The essential oils of aerial parts of *Tagetes erecta* showed considerable cytotoxicity against *Artemia salina* with ED50 value of 3.16mg/mL (De Feo *et al,* 2005).While the dichloromethane and methanolic extracts of the aerial parts of the plant from Argentine were reported for significant insecticidal activity against *Sitophilus oryzae* (Broussalis *et al.,* 1999).

Hepatoprotective activity

The hepatoprotective activity of flowers of *Tagetes erecta* by carbon tetrachloride induced hepatopathy model was determined. The CCL_4 treated rats showed the increase in serum ALT, AST, ALP and bilirubin levels. Ethyl acetate fraction of Tagetes *erecta* (EATE) at the dose of 400 mg/kg orally significantly decreased the elevated serum marker

enzymes and level of bilirubin almost to the normal level compared to the CCL_4-intoxicated group. Historical changes in the liver of rats treated with 400 mg/kg of (EATE) extract and CCL_4 showed a significant recovery except cytoplasmic vascular degenerations around portal tracts, mild inflammation and foci of lobular inflammation. Phytoconstituents such as flavanoids, terpenoids and steroids are responsible for the observed hepatoprotective activity (Giri *et al.,* 2011).

Anti-bacterial Activity

The anti- bacterial activity of different solvents of *Tagetes erecta* flower show against *Alcaligenes faecalis, Bacillus cereus, Campylobacter coli, Escherichia coli, klebisella pneumonia, streptococcus pyogens.* The flavanoids petulitrin is one the potential elements for its anti bacterial activity (Sharma *et al.,* 2011).

Nutrient agar medium was used for antibacterial assay and the inoculums was prepared by inoculating 0.2ml of overnight cultures of each organism into 20ml of sterile nutrient broth and incubated at 37°C for 3-5 hrs to standardize the culture to produce 106 cfu/ml. Antibacterial activity of the flavanoids (10 mg/100ml) was tested by disc diffusion assay Antibacterial activity of the flavanoids (10 mg/100ml) was higher for all the tested strains than that of the antibiotic tetracycline. Inhibition is maximum for *Klebsiella pneumonia* (29.50 mm) and minimum for *Pseudomonas aeruginosa* (21.00 mm) (Bauer *et al*., 1996).

Anti-oxidant activity

For in Vitro antioxidant activity three different assays like DPPH, reducing power and super oxide radical scavenging activity at different concentrations were used. In all the three assay, *Tagetes erecta* showed better reducing power than the standard (i.e. ascorbic acid), and super oxide anion scavenging activity and DPPH antioxidant activity showed less than standard. The antioxidant activity of the extracts and the composition of antioxidant compounds in the extracts were investigated. The content of total phenolic and flavanoids in the extracts was significantly varied with different solvents ($P<0.05$) and the extract by ethyl alcohol /water (7:3, v/v) has the highest content of total phenolic and flavanoids, 62.33 mg gallic acid equivalents (GAE)/g and 97.00 mg rutin equivalent (RE)/g, respectively (Chivde *et al.,* 2011).

Mosquitocidal activity

The Mosquitocidal activity in Ethanolic, chloroform and petroleum ether extracts of *Tagetes erecta* flower against different strains of *Cx.quinquefasciatus*. Among the tested samples the chloroform soluble fraction showed the highest toxicity and constituently the LC50 values (14.14 µg/mL, 1.706 µg/mL, 36.88 µg/mL and 75 µg/mL) and for all instars larvae of *Cx.quinquefasciatus*. The larvae showed comparative tolerance in the course of increasing age and time. From this they concluded that the flower of Tagetes erecta having good Mosquitocidal activity (Rahman *et al.,* 2009).

Wound healing activity

The wound healing activity of carbopol gels prepared from hydro alcoholic extracts of *Tagetes erecta* Linn. (TE) in excision wound model and burn wound models in albino mice. In excision and burn wound models, TE treated animals showed significant reduction in period of epithelization and wound contraction and combined gel showed accelerated wound healing activity may be because of synergism. The enhanced wound healing activity of hydro alcoholic extracts may be due to free radical scavenging action and the phytoconstituents (flavanoids) present in it which either due to their individual or additive effect fastens the process of wound healing (Ibrahim *et al*., 2011).

The treatment with hydro alcoholic extract of *Tagetes erecta* have beneficial influence various phase of wound healing fibroplasias, collagen synthesis and wound contraction result in faster healing The crude extract of *Tagetes erecta* significantly stimulated wound contraction, breaking strength of the incision wound and increased in the dry granulation weight in the treated group compared with extract of *Tagetes erecta* (Chatterjee *et al.,* 2011).

T. erecta extract (250 and 500 mg/kg) showed significantly increased the wound breaking strength in incision wound model and wet and dry granulation tissue weights, breaking strength in a dead space wound model (Alam *et al*., 2005).

Larvicidal activity

The larvicidal activity of essential oil from *Tagetes erecta* against 3rd instars of *Aedes aegypti,* the oil obtained by steam distillation and analyzed by gas chromatography/ mass spectrometry showed 14 d-limonene and piperitenone. The essential oil was active larvae of *Aedes aegypti*, with LC50 of 79.78 µg/ml and LC90 of 100.84 µg/ml. The larvicidal thiophenes contents were higher in the roots and flowers as demonstrated by high-performance liquid chromatography analysis. Thus, Tagetes erecta constituents a good source of varied compounds showing larvicidal activity against *Aedes aegypti* (Marcia *et al.,* 2011).

Anti hyperlipedemic activity

The antihyperlipedemic activity of hydro alcoholic extract of *Tagetes erecta* in hyperlipedemic rats at a dose of 200 and 400 mg/kg. Hyperlipedemic was induced by cholesterol 25 kg/day. Lovastatin (10mg/kg/day) was used as standard. Blood samples were collected from rats in all groups on 30th day and estimated for their serum cholesterol, serum triglyceride, serum HDL and LDL levels using standards procedures. From the study it was observed that administration of *Tagetes erecta* extracts significantly decreased all the hyperlipedemic parameters in rats (Raghuveer *et al.,* 2011).

Anti- diabetic activity

Hydro alcoholic extract of *Tagetes erecta* its anti diabetic activity by inducing diabetes using single intra-peritoneal injection of streptozotocin (60 mg/kg b.w.). Treatment with standard drug Glibenclamide, blood glucose rose at 30 min followed by subsequent fall up to 120 min. The administration of *Tagetes erecta extracts* showed increase in glucose levels after 30 min and hypoglycemia effect was observed only after 120 min (Raghuveer et al., 2011).

Cytotoxic activity

Lutein was isolated from rhizomes of *Tagetes erecta.* The isolated pigments were quantified spectroscopically and separated by thin layer chromatography. The active components of the pigments were further purified and identified by high performance liquid chromatography. In vitro cytotoxic activity of extract against Hep2 cancer cell lines were evaluated. The activity sample showing cell viability of more than 97% at 0.078mg/ml were considered to be less which are most suitable to perform cytotoxic study (Niraikulam 2013).

Anti-epileptic activity

EtE of flowers of the *Tagetes erecta* is considered to be effective in the treatment of epilepsy as in Ayurveda, but the phytoconstituents in EtE devoid of anti epileptic activity, but they found with phytoconstituents which decreases seizures threshold such menthol, indole alkaloids and verbenone. Menthol is already providing to be proconvulsant in nature, indole alkaloids are CNS stimulants thus may reduce seizures threshold and verbenone is found to be antidepressant**.**

Tagetes erecta may have CNS stimulant property; may be due to the presence of indole as one of the major phytoconstituents. Due to the CNS stimulants and antidepressant property of the EtE; may decrease the seizures thresholds, it may cautious if used in epileptic patients (James et al., 1996).

Anti-inflammatory activity

Acute inflammation was produce by injecting 0.1ml of 1% of Carrageenan into the plantar surface of rat hind paw. The extract (100, 200 and 400mg/kg, orally) and phenylbutazone (PBZ, 100mg/kg, orally) as reference drug were administered 60 min. before carrageenan injection. The paw volume was measured at 0, 0.5, 1, 2, 3 and 4 pethysmometrically. The orally administered extract significantly reduces pain induced by acetic acid writhing response. The number of writhing reflexes in treated mice decreased significantly and was comparable to ASA. No significant change in thermal stimuli was found (Vogel 2002).

Antinociceptive activity

Tagetes erecta sixty minutes after extract administration 0.1 ml of 1% v/v acetic acid was injected. The number of abdominal contraction over a period of 20 min was noted. Acetylsalicylic acid (ASA, 100mg/kg, orally) was used as positive control. Significant reduction in the no. of abdominal contraction ($p<0.05$) compared to the control (that received 0.3 ml normal saline) was considered as Antinociceptive action (kulkarni *et al.,* 2005).

Ovicidal and repellant activity

The ethyl acetate, acetone and methanol extract of *Tagetes erecta* leaves for oviposition- deterrent, Ovicidal and repellent activity against malaria vector, *Anopheles subpictus* grassi and emphasized on mosquito control facing a threat due to the emergence of resistance to synthetic insecticides and potential insecticides of plants origin which may serve as suitable alternative bicontrol techniques in the future (Elango *et al.,* 2011).

MARKETED PREPARATIONS

Sr. No	Formulation	Manufactured by	Composition	Doses	Uses
1.	LUTIGOLD 	PURITAN'S PRIDE, PVT LTD	Lutein, Zeaxanthin, Sunflower Oil, Gelatin, Vegetable Glycerin, Yellow Beeswax	40mg For Adults, take one soft gel daily, preferable with a meal.	Supports eye Health. Lutein plays a role in maintenance of eye health and its principle Cartenoids found in the central area of retina called the macula.
2.	LIGHT DAY LOTION SPF 25 	Mountain Valley Springs Pvt Ltd	Aqua, *Prunus Amygdalus Dulcis* (Sweet Almond) Kernel Oil, *Triticum Vulgare* (Genhu) Extract, Glycerin. *Morus Alba* (Mulberry) Fruit Extract, , *Simmondsia Chinensis* (Jojoba) Seed oil *Oryzae Sativa* (Rice)Bran oil*, Withania Somnifgera (Ashwagandha)* Root Extract, *Tribulus Terrestris* (Gokharu) Seed Extract, Garcinia Indica (Kokum) Seed Butter *Oryza Sativa (*Rice*) Bran Oil, Cera Alba*(Beeswax), Tocopheryl Acetate (Vitamin E) Yashad Bhasma*, Rosa Damascena* (Rose) Flower Oil, *Tagetes Erecta*(Marigold) Flower Extract	40ML	It protects our skin from the damaging effect of free radicals and from UV and pollution along with oxidant and antiageing properties. It helps our skin to retain its natural texture.
3.	ABLE EYES 	Carlson Division of J.R Carlson Laboratories, Inc, Arlington Hts, IL 60004	Vitamin A, Vitamin C, Vitamin D3, Vitamin E, Magnesium, Zinc, Selenium, Chromium, DHA (Docosahexaenoic Acid) Lutein Esters, Zeaxanthin, Bilberry Extract, Citrus Bioflavonoid Complex, Quercitin Dehydrate, Milk Thisle Extract, NAC (N-Acetyl Cysteine)	30softgels Adult. take 1 Soft gel once/twice daily at mealtime	Promotes Healthy Vision. Provides the important omega-3 DNA, Antioxidants and lutein

4.	OCUVITE 	Bausch & Lomb Incorporated, Rochester. NY 14609	Vitamin A, Vitamin C, Vitamin E, Zinc Selenium, Copper, Lutein	Adults: One tablet per day	Eye Vitamin And Mineral supplement. This medication is a multivitamin product prevents deficiency due to poor diet, certain illness or during pregnancy.
5.	URTIPLEX Anti-itch lotion 	Charak Pharm Pvt Ltd	Kumari(Aloe Vera),Marigold oil(*Tagetes erecta*) and KOKUM BUTTER Sarson oil(*Brassica campestris*), Menthol	100ml	Cools and soothes the skin. Relieves itching. Exhibits antiseptic properties.
6.	BIOPHIX 	Biophix Health & Nutrition 13165 NW 47THAve.Opa-locka,Fl 33054	Vitamin A, DHA(from algae, life' DHA)(*Schizochytriumsp)* Lutein(*Tagetes erecta*)	Take 1 soft gel daily with meal	Clinical strength Retinal support& Lutein is a critical pigment that supports the macula and lens.
7.	CAROTENALL 	Jarrow FORMULAS	Beta Carotene, Vitamin A[retinol],Lutein (*Tagetes erecta)*,Zeaxanthin(*Tagetes erecta*) Lycopene, Astaxanthin, Alpha carotene, Alpha Carotene, Gamma Tocopherol	60softgels	For cardiovascular and vision health Lycopene is an antioxidant cartenoids extract from non-GMO tomatoes. Lycopene supports healthy prostate function and protects against damage from the reactive oxygen species singlet species.
8.	NATURAL HAIR SOAP 	LEBEL COMPANY PVT. LIMITED	Vitamin E, Lutein (Tagetes erecta), gallic acid, β- sitosterol, 7 hydroxy sitosterol, lupeol erythrodiol.	NET 24.3 FL,OZ 720ml	*Tagetes erecta* containing Calendulin which keeps the hairs and scalp in excellent conditions, healthy hairs.

9.	Moisturizing cream 	Group DLP-Daily Luxury Product, Cosmetic Plant, SHALOAH SKINCARE	Vitamin A, Vitamin E, Panthenol, UV filter (*Tagetes erecta*)	25gm, 100gm 200gm, 500gm.	Moisturizing cream use as moisturizer to treat or prevent dry, rough, scaly, itchy skin and minor skin irritations.
10.	Nutralite (Multi Carotene) 	Amway	It contains all Natural cartenoids compounds from three concentrates (*Dunaliella salina algae,* tomato and *Tagetes erecta*. Nutralite contains (beta carotene, Lycopene and Lutein). Beta-carotene is a rich source of vitamin A and antioxidants.	90 (softgel)	This product can use for the nutritional gaps in cartenoids intake and is intended for daily use to support skin health, eye health and to provide wide range of antioxidant activity.

CONCLUSION

The detailed review on plant Tagetes erecta shows that as an herbal plant it offers a wide variety of pharmacological activities such as antimicrobial activity, wound healing activity, hepatoprotective activity, Mosquitocidal activity, antioxidant activity etc. Many Indian herbs are being used in traditional practices to cure various human ailments. Tagetes erecta has an important place among such anti- inflammatory medicinal plants; it can also be used in treating wound, cancer, liver disorder and diabetes. Furthermore, in future study, the isolated principles from Tagetes erecta needs to be evaluated in scientific manner using various innovative experimental models and clinical trials to understand its mechanism of action, in search of other active constituents, so that its other therapeutic uses can be widely explored. Therefore *Tagetes erecta* can be considered as a solution of several ailments and can be explored further.

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