

An overview of recent studies on antibacterial, antifungal, antiviral and antioxidant potential of *Tagetes patula*

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Abstract

*Marigold a very common ornamental plant was traditionally used in various ailments and for cultural purposes has grasped the attention of the researcher to evaluate its potential and enhance its therapeutic profile. The most common species of marigold are *Tagetes erecta*, *Tagetes patula* and *Calendula officinalis*. The flowers and leaves are the main parts which is responsible for the therapeutic efficacies. *Tagetes patula* also called as French marigold or genda in Hindi belong to the family Asteraceae consist of various phytoconstituents such as alkaloids, flavonoids, glycosides, gum resins and volatile and essential oils with wide range of activities. The flower of the plant has been used as an ornament for worshipping the god since ancient times. In the present review an attempt has been made to compile and update the profile of the plant and its antibacterial, antifungal, antiviral and antioxidant potential.*

Keywords: *Marigold, Tagetes patula, anti-bacterial, anti-oxidant, anti-viral.*

Introduction

Medicinal plants and the various plant products have been utilized since the ancient times by the humans for various purposes. The medicinally active plants have been observed to be rich sources of different products or ingredients that are effectively helpful in the process of drug development. According to the Indian system of medicine i.e. 'Ayurveda' it has been researched that many herbal remedies or natural plant products have been practiced in various medical treatises for the precaution, prevention and treatment of different ailments and diseases. The productive effect of the herbal medicine is because of the presence of various phytoconstituents or secondary metabolites such as glycoside, alkaloid, flavonoids, saponins, tannins, volatile oils, essential oils, gum resins, and tannins (Shetty et al., 2015).

Tagetes species plant has been grown in the world at large for the main purpose as a ornamental plant. *Tagetes* commonly called as marigold belonging to the family Asteraceae contains approximately 50 plant species. The plant *Tagetes* have various species amongst which the most commonly found is *Tagetes erecta* locally known as 'Genda' which originated from Mexico and found in various parts of America, Africa, and India. Marigold or the 'Genda Phool' has been used for various ornamental purposes (Singh et al., 2020).

The vernacular name of *Tagetes patula* in Hindi is genda, gainda, taigetej petulla, sthulapushpa. Flowers and leaves of the plant are edible which are used as in refreshing drinks and flavouring foods respectively. It is bushy, herbaceous, erect and glabrous annual plant. Research reported that it has been found to be non-toxic (Lim, 2014). *Tagetes erecta* and *Tagetes patula* as a whole plant have been proved to have various beneficial pharmacological actions. The stem bark, flower, and leaves have been reported to be effective in various applications such as anti-microbial, anti-bacterial, hepatoprotective, anti-inflammatory and anti- hyperlipidemic activities (Singh et al., 2019). *Tagetes* plant species have also been proved to have a very effective wound healing property and can also be used in muscular pain. It has also been proven to depict the insecticidal, mosquitocidal, nematicidal, laticidal, and ovicidal activity (Gopi et al., 2012).

Description of *Tagetes patula*

Tagetes patula is French marigold which is 5-18 inches tall having red orange bicolored flowers identical to saffron (Dixit et al., 2013). It is an annual herb and a yellow coloured dye is obtained from the flowers of the plant and is used for dyeing of textiles. The essential oils obtained from the plant have been used in the perfumery industry. Flowers have pungent, bitter, and acrid taste and a good remedy for fever. Leaves are good remedy for earache, kidney problems, ophthalmia, and muscular pain (Rahman, 2013). *Tagetes patula* is commonly called as French marigold because it was basically found in France. It is also called as dwarf marigold. It is 20-30cm tall possessing bicolor flowers with yellow or orange colours. Stem is 10-40 cm in length with a pale green colour. Leaves are broadly oblong and acute at the apex. Leaflets are lanceolate and glabrous (Riaz et al., 2020).



Figure 1: *Tagetes patula* plant

Geographic locations

Tagetes patula Linn also called as French marigold and locally known as ‘jafri’ is a member of Asteraceae family. Another common *Tagetes species* is used as a folk medicine in Bangladesh. This plant species are found in Mexico, America, and Bangladesh. In India it is found in Assam, Kerala, and Manipur.

Table 1: A pharmacological overview on *Tagetes patula* found in the Asian countries with their traditional uses.

Region	Part used	Therapeutic use	References
<i>Tagetes patula</i> (India)			
Gujrat	Flower	Ear pus, ear ache	Maru et al., 2018
Assam	Flower, leaves, seed	Tooth ache, ear diseases	Das and Hazarika, 2015
West Bengal	Flower, leaves	Neck pain, cough problem	Biswakarma et al., 2015
Tamil Nadu	Flower	Worship	Ayyanar et al., 2010
<i>Tagetes patula</i> (Bangladesh)			
Bogra	Leaves, whole plant	Muscular pain, and bronchitis	Rahman and Keya, 2015
Jhenaidah	Leaf	Bleeding, cut and wounds	Tumpa et al., 2014
Raji Shahi	Leaves, flower	Piles, muscular and kidney troubles	Rahman, 2013
<i>Tagetes patula</i> (Pakistan)			
Chakwal	Leaves	Ear ache	Malik et al., 2015
South Waziristan	Flower	Ornamental	Farooq et al., 2012

Mainwali	Fruits	Piles	Ahmad, 2006 and Sultana, 2006
<i>Tagetes patula</i> (Nepal)			
Chepang	Fruits	Ceremonial	Rijal, 2011
Kathmandu	Flower	Headache, cough	Ranjitkar and Rajbhandary, 2008
Kanchanpur	Plant juice	Pain, cut wounds and skin diseases	Dhami, 2008

Chemical composition

The plant *Tagetes patula* also called as French marigold has been found to contain variety of chemical constituents of various therapeutic uses. It has been observed to contain mainly benzofuran derivatives, thiophene derivatives, alkaloids and flavonoids (Li-wei et al., 2014).

Table 2: Secondary metabolites of *Tagetes patula*

Secondary metabolite	Chemical constituents
Benzofuran derivatives	Isoeuparin, dehydrotremetone, 14-isobutyryloxyeuparin, hydroxytremetone, euparin (Li-wei et al., 2014)
Thiophene derivatives	5-(3-butene-1-ynyl)-2,2'-bithiophene, <i>cis</i> -5-(1-acetoxy-but-3-enyl)-2,2'-bithienyl (Li-wei et al., 2014)
Alkaloids	Jafrine (Li-wei et al., 2014)
Flavonoids	Quercetagetin-5-methyl ether, quercetagetin-7-O-glucoside, kaempferol, myricetin (Li-wei et al., 2014)

Tagetes patula is a medicinal indigenous plant of tropical America but it is also cultivated in Pakistan. Different parts consist of different chemical constituents in leaves, roots, and flowers. The class of compounds commonly found in *Tagetes patula* are thiophenes, steroidal, and terpenoidal (Bano et al., 2002). The roots of *Tagetes patula* have been found to contain bithienyls. The seed have been observed to show the presence of patuletin and patuletrin (Vasudevan et al., 1999). According to a research article a new acyclic monoterpene glycosidal compound was isolated for *Tagetes patula* named as 2-methyl-6-methylen-2, 7-octadiene 1-O- β -D-glucopyrano-side (Garg et al., 1999). The major compounds of *Tagetes patula* obtained by hydro distillation from Venezuela andes were basically essential oils such as piperitone, trans- β -ocymene, terpinolene and β -caryophyllene (Rondon et al., 2006). The petroleum ether extract of *Tagetes patula* flowers consists of a β -barboline alkaloid called as jafrine (Shaheen et al., 2002).

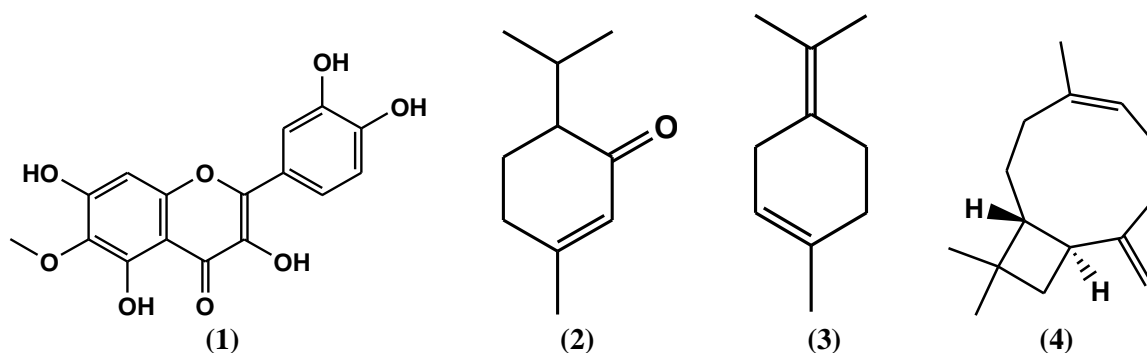


Figure 2: Structures of patuletin(1), piperitone(2), terpinolene(3) and β -caryophyllene(4).

Table 3: A comparative profile of different chemical constituents present in various parts of *Tagetes patula*

Plant	Part of plant	Chemical constituents
<i>Tagetes patula</i> (French marigold)	Flower	Carotenoids - galenine, lutein, α -carotene, β -carotene, γ -carotene, and lycopene (Vasudevan et al., 1999), Essential oils – α -terthienyl, pentatriacontane, 2-ethyl-1-dodecanol (Martínez et al., 2009), β -caryophyllene (Szarka et al., 2006), Leutin and leutin esters (Piccaglia et al., 1998)
	Leaf	Flavonoids - quercetagin and patuletrin and their glycosides (Vasudevan et al., 1999), Essential oils – terpenoline (Szarka et al., 2006)
	Stem	Essential oils – limonene, terpinolene, piperitone, sabinene, β -caryophyllene, α -pinene (Restello et al., 2009)
	Root	Volatile oils – 5-(3-buten-1-ynyl)-2, 2-bithienyl (Szarka et al., 2006), α -gurjunene, β -caryophyllene and β -farnesene (Piccaglia et al., 1998)

Therapeutic overview

Tagetes patula L. plant has been very common ornamental plant but it also has a wide range of pharmacological activities. It is widely distributed across the world and is used for various different purposes as traditionally as well as medicinally active plant.

1. Anti-bacterial potential

The compounds extracted from the essential oils of *Tagetes patula* in the preflowering stage such as (*Z*)- β -ocimene, α -terpinolene, piperitenone, limonene and propanedinitrile contributes in the antibacterial activity against certain bacteria's such as *Bacillus* sp., *Listeria monocytogenes*, *E. coli* and *Pseudomonas aeruginosa* (Kafaltiya et al., 2022). The ethanol extract of flower of *Tagetes patula* was evaluated for the anti-microbial activity by the assay of well diffusion and agar dilution. The results reported an effective antibacterial activity

against various gram (+) and gram (-) bacteria's such as *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Shigella flexenari*, *Salmonella typhi*, and *Pseudomonas aeruginosa* (Mumtaz et al., 2020). *Tagetes patula* was evaluated for anti-microbial activity and reported to be effective against different strains of micro-organisms such as *Escherichia coli*, *Staphylococcus* species, *Streptococcus* species, *Vibrio parahaemolyticus*, *Micrococcus luteus*, and *Bacillus megaterium* (Mumtaz et al., 2020 and Salehi et al., 2018). The hot aqueous extract of *Tagetes patula* was researched for the antibacterial activity which proved out to be beneficial and effective. The flowers of *Tagetes patula* depicted a broad spectrum of anti-bacterial activity against various list of bacteria's such as *Proteus vulgaris*, *Staphylococcus aureus*, *Salmonella enterica*, *Bacillus subtilis*, and *Bacillus cereus* (Faizi et al., 2008). According to Faizi et al. (2008) the petroleum ether and methanolic extract of *Tagetes patula* was evaluated for the antibacterial and antifungal activities. From the observation it was found that the methanolic extract of the flowers of the plant were active against different bacteria called as *Streptococcus* species, *Staphylococcus* species, *Corynebacterium* species, and *Micrococcus luteus* because of the presence of flavonoids (Faizi et al., 2008).

2. Anti-fungal potential

According to a recent research, nanomedicine approach was taken into consideration. The silver nanoparticles were synthesized from the aqueous extract of leaves of *Tagetes patula* and were tested for antifungal activity against phytopathogenic fungi. It was observed that the leaves of French marigold aqueous extract taken with silver nitrate solution was used to prepare silver nanoparticles and it was effective against the growth of phytopathogenic fungi, *Collitotrichum chlorophyte* (Sukhwal et al., 2017). According to Politi et al. (2016) *Tagetes patula* was observed to have a wide range of glycosylated flavonoids and thiophenes in the extract. It was observed to show anti-microbial activity with the help of ethanolic extract of *Tagetes patula* flowers against some fungi such as *Microsporium canis* and *Trichophyton rubrum* (Potili et al., 2016). The extract of *Tagetes patula* obtained from the roots was evaluated for antifungal activity against *Fusarium oxysporum* and influence on watermelon was investigated. The result obtained proves that the essential oils present in the roots shows high fungicidal activity and reduces the harm of fungi to watermelon (ZhiHong et al., 2010). The anti-fungal activity of *Tagetes patula* was evaluated against phytopathogenic fungi such as *Botrytis cinerea*, *Fusarium moniliforme* and *Pythium ultimum*. The observations on *Pythium ultimum* were found to be highly effective as compared to the other fungi with specific cell alterations which inhibit the growth of these fungi (Mares et al., 2004).

The indole acetic acid isolated from the roots of *Tagetes patula* indicated an antimicrobial activity and can be used as a plant growth hormone for the better crops production. The presence of L-tryptophan depicted the anti-microbial activity against *Xanthomonas campestris* and has positive effect on plant shoot and root growth (Chhetri et al., 2022).

3. Anti-viral potential

According to the computational studies recently it was established that the flavonoid extracted from the flower of *Tagetes patula* originated from Egypt can be proven to have beneficial effects against SARS-CoV-2, hence it can be preventive against the Covid virus. This can be linked with the structural similarity of patuletin with F68 the ligand for SARS-CoV-2 which can be a future for the prevention of COVID virus (Metwaly et al., 2022).

4. Anti-oxidant potential

The exopolysaccharide produced from the *Lysobacter sp.* was isolated from the roots of *Tagetes patula* depicted an anti-oxidant activity via DPPH scavenging test and hence can be a promising moiety for different biological activities (Kim et al., 2022). The ethanolic extract of *Tagetes patula* have been proven to have an antioxidant activity which may be helpful in preventing skin ageing. This results in better inhibitory activity of of elastase, tyrosinase and hyaluronidase which proves that it can be used as an bioactive compound against skin aging-related enzyme activity (Chompoo et al., 2021). In a study, Kushwaha *et al.* (2020) evaluated the antioxidant potential of *Tagetes patula* via DPPH scavenging assay. The total phenolic and flavonoid content was first evaluated and then methanolic and water extract under-go DPPH scavenging activity. According to the statistical analysis and evaluation of percentage of inhibition it was observed that due to the presence of high phenolic and flavonoid content in the methanolic extract of disco yellow variety of *Tagetes patula* it has highest antioxidant activity (Kushwaha et al., 2020). The varieties of *Tagetes patula* have different lutein content and the flower extract were evaluated for *in-vitro* antioxidant activity via DPPH and ABTS radical scavenging activity. Results depict that *Tagetes patula* with orange flowers have highest content of lutein and have maximum potential of radical scavenging of DPPH and ABTS activity (Bhattacharyya et al., 2010).

Conclusion

French marigold biologically known as *Tagetes patula* belonging to the family Asteraceae has a vast range of therapeutic potential and has been proved to be effective against various ailments. The main characteristic feature of the plant is bicoloured flower (orange-red) having close resemblance to saffron. The flowers and leaves of the plant are edible and have been reported to be non-toxic.

The comprehensive review of pharmacological properties of *Tagetes patula* was established due to the presence of flavonoids and phenolic compounds. Some of the researches also depict that essential oils present in the plant are also responsible for different pharmacological activity. Many pharmacological activities need to be validated and confirmed with the help of clinical trial so that it can be utilized as an effective and efficient source to be used against different ailments.

Conflicts of Interest

All authors declare no conflict of interest.

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