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Pharmacognostical and Phytopharmacological Study of Tagetes Patula L.

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KEYWORDS

Antioxidant, phytopharmacological study, *Tagetes patula* capitulum, microscopical study.

ABSTRACT:

Background: *Tagetes patula* an ornamental medicinal plant commonly known as the French marigold is the Asteraceae family's most widely distributed species. The plant has antioxidant, antibacterial, anti-inflammatory, anti-cancer, and antifungal activity; traditionally used to treat skin, eye infections, wounds, and digestive issues.

Aim: The present study endows with significant information about its pharmacognostical and phytopharmacological studies, and its therapeutic qualities as a traditional remedy for a variety of diseases.

Method: The fresh flowering top of the plant was used to examine macroscopic, microscopic, and physico-chemical parameters. The capitula of the plant were investigated by the microscopic sections and quantitative analysis, including extractive value in n-hexane and methanol, total ash, acid-insoluble ash, water soluble ash, crude fiber content, and loss on drying (LOD). The extractives in n-hexane and methanol obtained by the successive soxhlet extraction were examined for different phytoconstituents using initial phytochemical assessments.

Results: The color, consistency, and percentage of ash, crude fiber content, moisture content, and extractive values in mean values ± SEM were calculated concerning the air-dried drug.

Conclusion: The entire plant can be extensively studied for phytochemical and pharmacological activities. Therefore, the scope of this paper is to standardize the *T. patulla* capitulum by pharmacognostic analysis, which has been attempted in the current work, and examines the phytochemical and multiple-purpose therapeutic values.

Introduction

Eating edible flowers was recorded in ancient writings from Asia, Greece, and Rome as well as medieval France, Victorian England, and the Middle East. It is native to Mexico; these plants develop organically from the country's valley southward to several other Latin American nations. However, some species have spread around the entire globe. Typically, people believed edible flowers had therapeutic benefits that would help people[1]. The genus *Tagetes* contains 50 annual or perennial species that range size-wise and are usually herbaceous plants belonging to the Asteraceae family. The blooms are produced in the central Mexican highlands, where it is native, from September till the death of frost[2]. Within 2-3 weeks of blooming, achenes ripen and fall off. If the soils have adequate drainage, it can grow in both clay and sandy soils. They belong to several plant groups that the English term "Marigolds". In Mexico, Guatemala, and other Asian nations, *Tagetes patula*, a French marigold, is utilized extensively during Day of the Dead festivities[3]. With thousands of varieties, it is extensively used as a bedding plant that is easy to

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grow. *T. minuta* is documented in Chinese flora, while some experts consider *T. patula* to be a synonym for *Tagetes erecta*[4]. This well-liked garden plant yields an intensely fragrant volatile oil that is mostly used in the creation of luxury fragrances. This plant is prized for its velvety, brightly colored, light-summer blooms that are chocolate, orange, and yellow. Although *Tagetes patula* can withstand temperatures between 1 and 5 °C, a low temperature can damage it. In the natural environment, beetles, tachinid flies, and other insects pollinate the heads, which are predominantly composed of hermaphrodite (containing both male and female organs) florets. Gardeners cultivate them in full sun and uniformly moist circumstances in soil that is relatively fertile but well-drained. Infusions made from dried leaves or florets are used for medicinal purposes in various civilizations[5]. Numerous pharmaceutical effects of the plant have been documented, including hypoglycemic, immune-stimulating, anti-depressant, anticonvulsant, memory-enhancing, aphrodisiac, antimicrobial, antioxidant, local anesthetic, insecticidal, impact on COX and LOX, association with testosterone, libido, and testicular interactions[6]. The root component mostly possesses advantageous qualities that can benefit humanity. Additionally, studies indicate that *T. patula* essential oil may be applied as a residual bedbug insecticide[7]. In this study, pharmacognostic methods were implemented to standardize the plant *T. patula* and phytochemical study confers current pharmacological research regarding the management of several affective disorders as well as several potential avenues for study.

1. Material and methods

1.1. Plant material

The flowers of the plant *T. patula* were collected in February 2023 from the local market of Mirzapur and authenticated from NBRI, Lucknow. A voucher specimen no. LWG113701 was retained for further reference.

1.2. Chemicals

All the chemicals and solvents used for extraction were procured from Merck (Mumbai, India).

1.3. Pharmacognostic and phytopharmacological study

The fresh flowering top of the plant was used to examine macroscopic, microscopic, and physico-chemical parameters. The flowers are disconnected from each capitulum and about 50 g of capitula are collected. Free-hand sectioning was used to cut the microscopic sections, and different capitula portions were examined. The standard Indian Pharmacopoeia process was used to ascertain the quantitative evaluation, which included extractive value in n-hexane and methanol, total ash, acid insoluble ash, water soluble ash, crude fiber content, and loss on drying (LOD)[8]. Using both polar and non-polar solvents such as n-hexane and methanol, successive soxhlet extractives of the dried capitula were performed, and the extractives' weight, color, and consistency were measured[9]. The extractives in n-hexane and methanol obtained by the successive soxhlet extraction underwent primary phytochemical analysis[10]. The phytoconstituents present in the other parts and the pharmacological studies of the plant are reported based on a literature search.

2. Results

3.1. Morphological study

The herbaceous annual and perennial *T. patula* plant is erect, terrestrial, and can reach a height of 1.6 feet. Pinnately divided into 4 to 6 pairs of pinnae, with moderately glossy green leaves with finely serrated edges. All marigold species have scented oil glands on their leaves. Golden, orange, and yellow blooms with maroon accents are common in nature. Usually having both ray and disc florets, floral heads have a diameter of 4–6 cm. Each capitulum is a yellowish-white colored, strongly fragrant, dome-shaped structure (Fig.1).

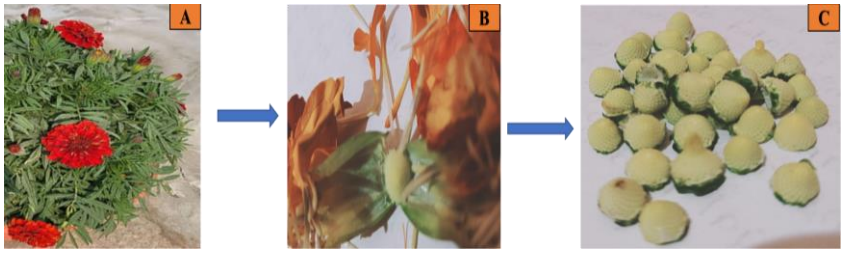

Figure.1. (A) *Taget patula* plant with flowers; (B) Opening of flower to remove capitulum; (C) Fresh capitula.

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3.2. Microscopical study

T.S. of the *T. patula* stem appears wavy in outline with ridges and furrows. The epidermal cell walls are thin and hairy. The outer cortex is cholenchymatous, while the inner cortex comprises thin-walled parenchymatous cells. In the cortex, 16-20 large and small vascular bundles are found to be arranged in a ring. The vascular bundles where two phloem patches, one xylem strand, and one strip of cambium are present on the same radius. The phloem is present towards the outer side and is called as secondary phloem and on the inner side is called the primary phloem. In between the xylem and phloem cambium strips are present **(Fig.2a. & Fig.2b.).**

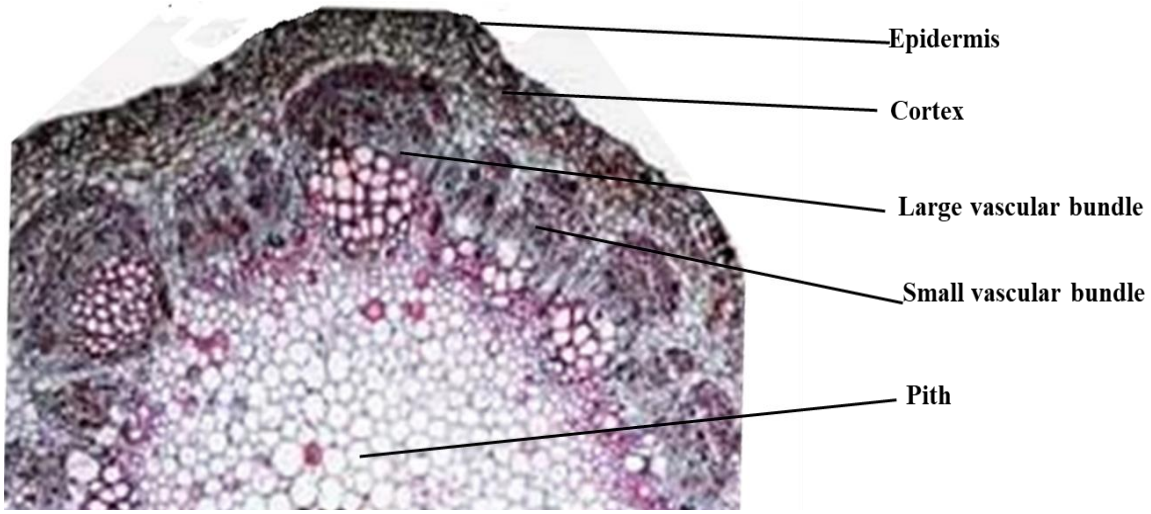

Figure.2a. Transverse section of stem of *Tagetes patula* (10X).

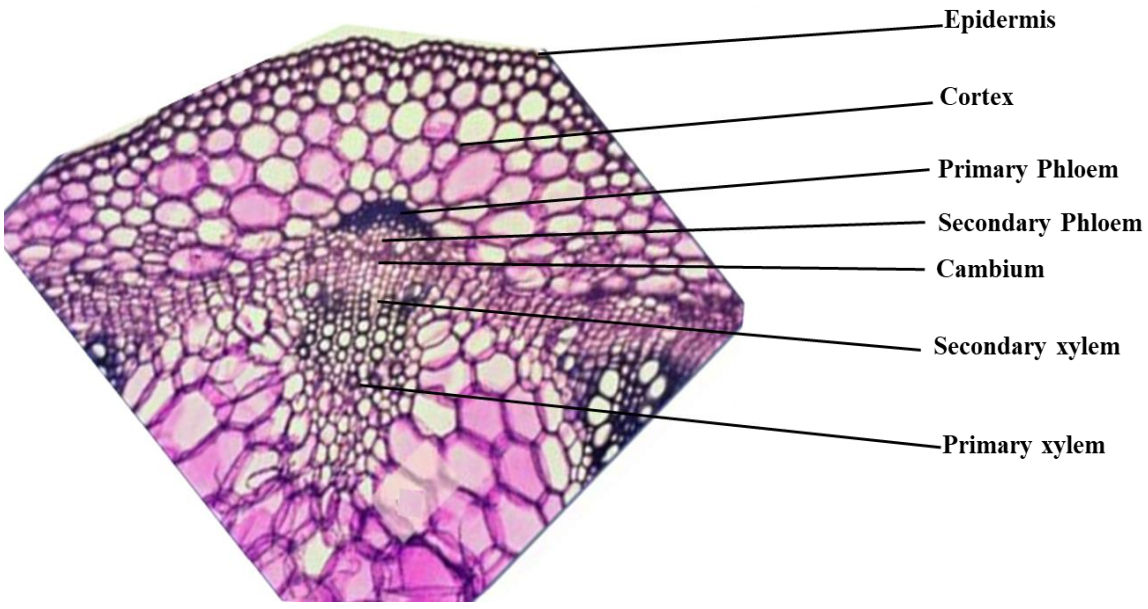

Figure.2b. Transverse section of stem of *Tagetes patula* showing vascular bundle (45X).

T.S. of the *T. patula* capitulum appears circular in outline with thin epidermal cell walls **(Fig. 3).** The cortex comprises thin-walled parenchymatous cells in which 12-14 vascular tracheids are found to be arranged in a ring. The vascular tracheids are filled with volatile oil and resins. A large air cavity in the center of the cortex is present, known as a pith.

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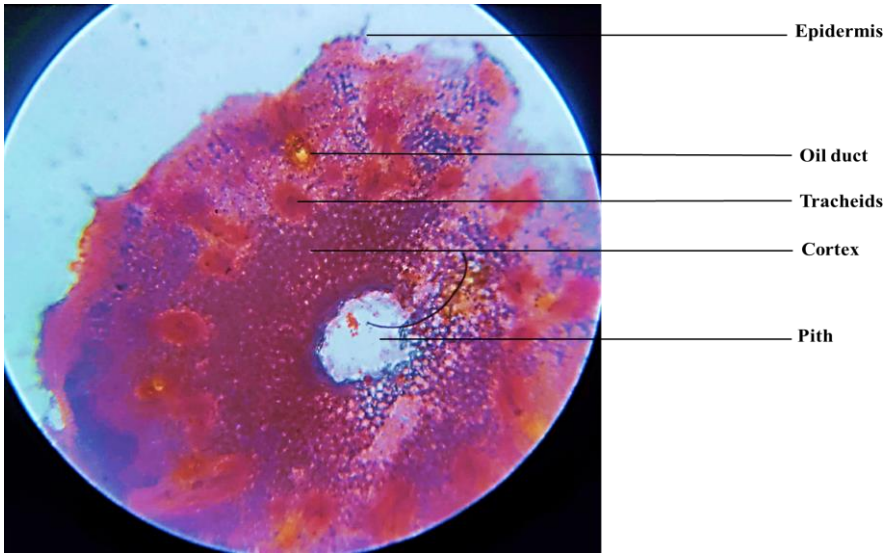

Figure.3. Transverse section of capitulum of *Tagetes patula* flower (10X).

3.3. Physicochemical and Phytochemical Studies

Quantitative standards of powdered capitula like moisture content, according to the Indian Pharmacopoeia, the dried sample's ash value and loss during drying were calculated; the findings are displayed in **(Table 1).** Extractive values for powdered capitula of *T. patula* with n-hexane and methanol were determined and results are mentioned in **(Table 2).** The phytoconstituents investigated by preliminary phytochemical test present in the n-hexane and methanol extractives have been mentioned in **(Table no.3).** From the literature, it was found that phytochemicals present in *T. patula* are divided into five groups (**Fig.4)** namely terpenes, thiophene, phenolic and flavonoids, carotenoids, and benzofuran derivatives.

Table 1: Quantitative standards for powdered capitula of *T. patula* (Values in %)

Parameters	Values in (Mean ± SEM)
1) Moisture content	48.6%
2) Loss on Drying	8.34%
3) Ash Value	
a) Total ash	2.46%
b) Acid insoluble ash	0.25%
c) Water-soluble ash	1.65%
d) Sulphated ash	0.66%
4) Crude fibre content	3.28%

Table 2: Extractive values for powdered capitula of *T. patula* with n-hexane and methanol

Solvents	Colour of the dried extract	Values in (%) (Mean ± SEM)
n-Hexane	Resinous white	2.28 ± 0.16
Methanol	Light brown	3.43 ± 0.67

Table 3: Preliminary phytochemical screening of n-hexane and methanolic extractives of *T. patula* capitula

Test	n-Hexane	Methanol
Alkaloids	–	–
Free sugars	–	+
Flavonoids	–	+
Anthraquinone	–	–
Saponins	+	+
Phenolics	–	+
Terpenoids	+	+
Steroids	+	+
Amino acids	–	+
Oil/resins	+	+

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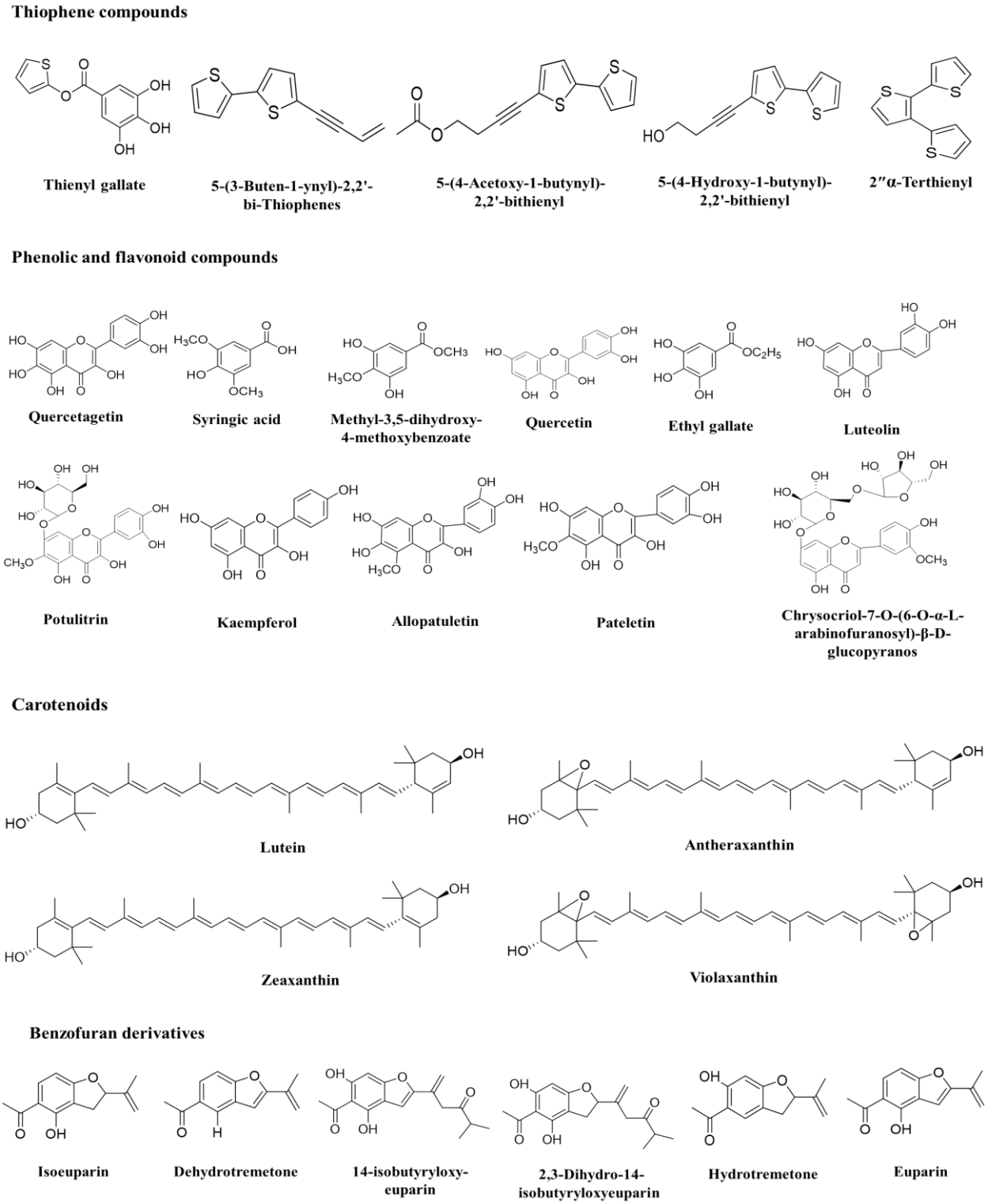

Fig. 4. Natural bioactive compounds found in different parts of *T. patula*

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3.4. Phytopharmacological study

From the literature, it was found that phytochemicals present in *T. patula* have been showed antioxidant, antimicrobial, anti-inflammatory, analgesic, antihypertensive and nematocidal activity **(Table no. 4).**

3. Discussion

According to the majority of research on *T. patula* flowers, lutein and zeaxanthi are the primary components of the yellow carotenoids that comprise xanthophyll[11]. Myristate, palmitate, stearate, distearate, and lutein-dimyristate are the most common ester forms of lutein found in *T. patula*. Since lutein cannot be synthesized by the human body and varying levels of lutein esters have been recorded based on flower color, dietary lutein is the primary source[12, 13].

To evaluate the antioxidant capacity of natural extracts and isolated compounds, several *in vitro* antioxidant activities were carried out. *T. patula* also can chelate metals because of the method in which its hydroxyls and carbonyl groups are arranged. It can also donate electrons or hydrogen to diminish free radicals and delocalize unpaired electrons to create stable phenoxyl radicals. The antioxidant activity of *T. patula* has been evaluated using a variety of antioxidant assays that use various reaction mechanisms, reaction stages, and outcomes. In current time, *T. patula* recognized antioxidant capacity does not support the related therapeutic benefits. Therefore, there is a great demand for molecular and mechanistic research using suitable models and standards[14,15].

The studied on the growth of organisms (*Trichophyton rubrum, Microsporum canis, Microsporum anisopliae, Trichophyton mentagrophytes,* and *Beauveria bassiana*) were significantly reduced in their development by the ethanol extract of *T. patula*[16]. The hydroalcoholic extracts of the plant showed inhibition of the *Trichoderma viride*[17]. Methanolic extract of *T. patula* plant showed growth inhibition at 5, 10, and 50 µg/ml against fungi (*Fusarium moniliforme, B. cinerea* and *Pythium ultimum*), the investigation was conducted in dark, UV-A, and sunny environments. In comparison with dark environments the activity was enhanced by sunlight and UV-A[18].

Acute and chronic inflammatory models were used to evaluate the *T. patula* floret methanol extract. The extract repressed acetic acid-induced vascular permeability in mice, dramatically prevented mustard-induced persistent oedema in mice, and prevented γ-carrageenan-induced mouse-paw swelling, which was caused by chemically-mediated agents in rodents in a dose-dependent way, as well as adjuvant-induced arthritis in rats. The first-stage inhibitory action on mediators and the subsequent modification of vascular permeability are responsible for the anti-inflammatory effect. It was determined that *T. patula* played a substantial impact in acute inflammation but a less noticeable role in chronic inflammation[19].

Mice's acetic acid-induced writhing was reduced by *T. patula* flowers' methanolic extract at 100 mg/kg, and separated patuletin showed stronger analgesic effects at doses of up to 10 mg/kg. In a hot-plate study demonstrating its peripheral efficacy, neither extracts nor isolated compounds exhibited any analgesic property[20]. Acetic acid-induced writhing in mice has been shown to respond to methanol extract from *T. patula* leaves in a dose-dependent manner[21].

Arterial blood pressure was lowered in a dose-dependent manner by *T. patula* root methanol extract and sub-fraction. At doses of 15 and 30 mg/kg, the root's citric and malic acids (methanol extract) reduced the rats' mean arterial blood pressure by 71 and 43%, respectively[22]. Rats with propylthiouracil-induced and Triton X-100-induced hyperlipidemia can be prevented by using *T. patula* methanol extract alone or in conjunction with piperine. Piperine increased the extract's bioavailability to have an antihyperlipidemic effect in this investigation. More importantly, the effect on blood pressure in terms of mechanisms such as angiotensin-converting enzyme (ACE) and in effort to manage the extract or medication when delivering it with another class of anti-hypertensive medications, obesity-mediated hypertension must be mentioned. The cited research does not describe the mechanism of action; they only assert that blood pressure has decreased[23].

The yellow flowers, polar extract, and fractions of *T. patula*, which are mostly composed of flavonoids and phenolic acids, exhibit nematocidal efficacy towards the cyst nematode *Heterodera zeae*. The nonpolar extract contained a small number of fatty acids, their methyl esters, and thiophenes, including α-T. Nematocidal activity against *Pratylenchus penetrans* was demonstrated by a non-polar root extract, primarily because of α-T[24].

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Table 4: Phytopharmacological study of *Tagetes patula*

Activity	Extract/Phyto-constituent	Observation
Antioxidant activity	crude extracts of the whole plant	*T. patula* can chelate metals because of the way its hydroxyls and carbonyl groups are arranged. It can also donate hydrogen or electrons to diminish free radicals and delocalize unpaired electrons to create stabilized phenoxyl radicals[14,15].
Antimicrobial activity	Ethanol extract of whole plant	The growth of the studied organisms (*Trichophyton rubrum, Microsporum canis, Microsporum anisopliae, Trichophyton mentagrophytes,* and *Beauveria bassian*) was inhibited by *T. patula* ethanol extract[16-18].
Anti-inflammatory activity	Florets methanol extract	In a dose-associated manner, the extract prevented γ-carrageenan from causing mouse paw swelling in rodents and adjuvant-induced arthritis in rats. It also prevented acetic acid from causing vascular permeability in rodents, significantly inhibited mustard-induced persistent oedema in mice. However, the cotton pellet-induced granuloma in rats was not inhibited[19].
Analgesic activity	Flowers methanolic extract	The methanol-based extract of *T. patula* blooms at 100 mg/kg reduced the writhing that rodents experienced when exposed to acetic acid, while the extracted patuletin at doses up to 10 mg/kg showed increased analgesic activity[20-21].
Antihypertensive activity	root methanol extract	When rodents were given amounts of 15 and 30 mg/kg of the root's citric and malic acids (methanolic extract), their mean arterial blood pressure dropped by 71 and 43%, respectively[22-23].
Nematocidal activity	*T. patula* yellow flowers, polar extract and fractions,	The yellow flowers of *T. patula*, which are primarily composed of flavonoids and phenolic acid, shown nematocidal efficacy against the cyst worm *Heterodera zeae*[24].

Due to their pungency, golden hue, and appeal in Western countries, dried and crushed flower petals are a common spice[25]. The spice adds a distinct earthy flavor that goes particularly well with clove and cinnamon flavors. Additionally, it is a necessary component of the spice mixture, which is used in cooking. Garam masala is used in North Indian cooking, which incorporates Mughlai cuisine[26]. The oil is used with sandalwood oil to create the scent known as "attar genda"[27].

4. Conclusion

Different parts of plants have been used as dietary supplements, nutraceuticals, traditional medicines, and important ingredients in modern drugs. Terpenoids, flavonoids, and phenolic compounds are examples of bioactive plant components with medicinal qualities that have a noticeable physiological impact on humans. The extracts of *T. patula* have antimicrobial properties that help fight bacterial and fungal infections, used in conventional medical practices to treat skin; eye infections, wounds, fungal diseases, arthritis, muscle pain, and swelling. Rich in flavonoids and carotenoids, which act as antioxidants to protect cells from damage which helps in slowing down aging and protecting against degenerative diseases. The essential oil has a calming effect and is used in aromatherapy to reduce stress and anxiety. Its natural nematicidal and insect-repelling properties make it valuable in companion planting and organic farming. Future trends may focus on integrating marigold-based pest control solutions in sustainable agriculture. Growing demand in the cosmetic, pharmaceutical, and pesticide industries could expand its commercial cultivation, and future research may lead to new herbal formulations and pharmaceutical applications.

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11. Author Contribution

Rajeev Kumar Singh: Experimental work; Muhammad Arif: Supervision of work; Sunil Mistry: Drafting of research findings; Rufaida Wasim: Drafting of research findings; Shom Prakash Kushwaha: Drafting of research findings; Pushpendra Soni: Drafting of research findings.

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