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Phytochemical analysis, traditional applications, Pharmacology and toxicity of Thymus serpyllum

P.NareshBabu , P.V.Madhava Reddy, Sk.Saleha Nageena, Sk.Phareedha

Article Info

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Abstract:

The Lamiaceae family understudied perennial plant *Thymus serpyllum L*. has a long history of use in the treatment of gastrointestinal and respiratory disorders in the higher foothills of India. Our present understanding of *T. serpyllum* traditional applications, phytochemistry, and pharmacology is not well-rounded, and that is the goal of this review. Gathering up-to-date knowledge on this plant is our top priority, as is promoting more in vivo and in vitro studies to back up local claims. Due to its varied pharmacological qualities, such as antioxidative, antibacterial, anti-inflammatory, and anticancer activity, the essential oil extracted from *T. serpyllum* has garnered substantial interest as a plant-derived product. When it comes to creating novel medications to tackle a wide range of health sector issues, ethnomedicinal research has shown that *T. serpyllum* has a lot of potential. Pharmacological investigations alone are insufficient to support the widespread usage of *T. serpyllum.* In most cases, researchers use either in vitro or in vivo methods. To evaluate these medical assertions, more research is needed in the form of carefully orchestrated pharmacological trials. The findings of this evaluation will serve as a springboard for more studies. Despite *T. serpyllum* extensive traditional usage, there has been a dearth of pharmacological research, with the majority of investigations conducted in either in vitro or in vivo settings. Important topics to explore include further chemical isolation, thorough pharmacological study, and potential culinary uses.

Keywords: Pharmacological properties, phytochemistry, *Thymus serpyllum*, toxicity, traditional applications

Introduction :

The contemporary world is responsible for improving immune responses and achieving excellent health via the use of medicinal herbs. For generations, from 4000 to 5000 B.C., people have turned to traditional remedies as a cost-effective and easily accessible means of illness treatment. The first known medicinal formulation derived from herbs was acquired by the Chinese. The first text on the use of plants as medicines in India was found in the Rig-Veda, which dates back to 1600-3500 B.C. Traditional Indian medicine has long made use of herbs for their therapeutic properties.[1] New medicinal treatments may be derived from plants.

Department of pharmcology
Ratnam Institute of Pharmacy, Pidathapolur (V), Muthukur (M), SPSR Nellore Dt.524001 A.P. Indi

 in a direct or indirect manner. The majority of the population in industrialized nations relies on conventional medicine for their health, as stated in studies by the World Health Organization (WHO).Both industrialized and developing nations are seeing a rise in the demand for medicinal herbs.

As a member of the Lamiaceae family and a major genus within it, thyme has a prominent place. There is evidence of this adaptable herb's use as a spice all across the globe. There are 7534 species in the thyme genus, including 220 species of thymus L., as reported in the World Checklist (http://apps.kew.org/wcsp/ incfamilies.do).the third Richard has successfully identified many species of Thymus all over whole planet.[4] The medicinal, cosmetic, perfume, and culinary sectors all make extensive use of members of the thyme genus.[5]

The common cold, flu, indigestion, nausea, kidney illness, ulceration, headache, diabetes, and asthenia are just some of the many ailments that thyme may help alleviate.[6] The main focus of studies is thyme oil, which contains phenolic chemicals, esters, and terpenes. The fragrant and medicinal properties of thyme have contributed to its status as one of the world's most beloved plants, and thyme oil is no exception. Many consider it to be among the top 10 essential oils (EOs) in the world.[7] Therefore, the purpose of this study is to provide up-to-date information on T. serpyllum pharmacological characteristics, phytochemical components, traditional uses, and safety profile. This study compiles pharmacological and phytochemical data that may be used to explore new avenues of treatment, fill knowledge gaps, and create effective intervention strategies.

Botanical Description and Geographic Distribution

T. serpyllum is a little shrub with a pleasant aroma and a cluster of glossy, pointed, blue-green leaves that gradually get browned. It goes under many names, including creeping thyme, wild thyme, Breckl and thyme. It may be found in many parts of East Africa as well as Asia, Europe, and North America. It grows in India specifically in the states of Uttarakhand, Jammu & Kashmir, and Himachal Pradesh.[8]

Perennial T. serpyllum shrubs may reach a height of 5–7 cm. Clusters of tiny, pinkish-purple blooms adorn its hairy, crawling look.[8] The lengthy trichomes cover the oval-shaped leaves, which are smooth on both sides and measure around 4-6 mm in length and 2-4 mm in breadth. Although the lateral veins at the margin's base are less evident, the central vein is powerful. All year round, these leaves are there. The hermaphroditic T. serpyllum plant depends on pollinators such as bees, flies, and butterflies that are drawn to its unique scent. It grows best in situations with a medium to dry moisture content and good drainage, and it loves sandy, rocky, loose, and nutrient-poor soil. Although it thrives in dry, windy conditions, this species is more common in shaded regions.[9] It needs more light and grows rapidly on normal damp soil.

Propagation via stem cuttings is a simple process.

Thymus serpyllum: A Traditional Herb with Modern Uses

and for therapeutic objectives. In addition to their long history of use in medicine, they have become an integral component of our culinary traditions and cultural practices.It has the quickest healing and bravery qualities, and it is historically taken by martyrs and fighters to gain physical strength, in addition to psychological perception [10].Greek doctors have long utilized the plant's juice to alleviate asthma and coughs, and they also recommend using the paste topically for the treatment of arthritis and the disinfection of cuts and scrapes. Greek medicine has a long history of using this plant's juice to cure asthma and coughs, while the plant's paste has exterior uses such as treating arthritis and disinfecting cuts and scrapes[13]. In addition, the leaves and flowering stems alleviate period cramps, period discomfort, and a host of skin problems, such as rashes and itching.[14] Along with its diuretic qualities, an infusion produced from T. serpyllum leaves and "jaggery" is well-known. In addition to their utility in treating respiratory and gastrointestinal issues, the aerial portions of T. serpyllum offer antiseptic, antiplasmodic, deodorant, and disinfecting properties [15]. T. serpyllum is an immunostimulant and has better blood circulation in the Western Balkans [16].Traditional medicine practitioners in India have traditionally relied on T. serpyllum to alleviate menstruation cramps [17].Furthermore, it has been used to reduce inflammation, edema, and eczema [18]. Ethnoveterinary medicine has also acknowledged its antidiarrheal effects. The year 19 One study found that acute pharyngitis was efficiently treated by mixing T. serpyllum with blackberry leaves (British

Pharmacopoeia, Commission Secretariat of the Medicines, and Healthcare Products Regulatory Agency, 2015). On top of that,to make herbal tea, T. serpyllum is a common ingredient.[20].

In addition to its usage in mouthwashes and gargles, the calming and disinfecting properties of T. serpyllum EO make it an effective weapon against a variety of illnesses.[21]

Plant biology

Over the last 20 years, a plethora of studies have investigated the phytoconstituents profile of T. serpyllum EO [Table 1].[22] is a The genus Thymus is classified by a number of chemical substances, including germacrenethymol, carvacrol, □-terpinyl acetate, linalool, geraniol, citral, and (E)-caryophyllene.[23] Thymol levels in essential oils extracted from thyme cultivated in India ranged from 60% to 64.6%, in contrast to those in essential oils extracted from thyme cultivated in Estonia, which ranged from 0% to 0.4%.Thymol (16.5%–18.8%), 4,8-cineole (14.0–18.0%), and thymoquinone (2.6%) were all reported by Aziz et al. [24].The essential oils of T. serpyllum cultivated in Muzaffarabad, Jammu include 1,8-cineole (14.0%-18.0%) and spathulenol (1.3%-2.1%).

Table1:Various classes of phytocompounds present in *Thymus serpyllum*

Category of phytocompounds	Phytoconstituents
Phenolic acid sand flavonoids	Gallic acid, rosmarinic acid, caffeic acid, ferulic acid, rosmarinic acid-glucoside, protocatechicacid,protocatechicacid-hexoside,chlorogenic acid,naringin,luteolin-o-diglucuronide, kaempferol-o-glucuronide,rutin,luteolin-o-glucuronide,apigenin-o-glucuronide,methylkaempferol-o-rutinoside,luteolin,luteolin-7-o-rutinoside,luteolin-7-o-glucoside,apigenin-7-o-glucoside, apigenin,quercetin,eriodictyol-7-o-glucuronide,8-prenylnaringenin,taxifolin,catechin,apigenin6,8-di-c-glucoside[28,29]
Triterpenic acid	Oleanolicacid,betulinicacid,ursolicacid,corosolicacid[29]
Monoterpene hydrocarbon	Tricyclene, α -Pinene, *o*-cymene, camphene,sabinene, β -pinene, β -cymene, α-phellandrene, myrcene,thymol, α-terpinene,*p*-cymene,limonene,α-thujene,terpinene,thymolacetate[30,31]
Monoterpene oxidized	1,8-Cineole, linalool,δ^3-carene,terpenolene,α-thujone,cis-sabinenehydrate,camphor,α-campholene,sabinene hydrate, trans-sabinene hydrate, borneol, isoborneol, *p*-mentha-3,8-diene, terpinen-4-ol,cis-sabinol, p-cymen-8-ol, cis-chrysanthenol, carvacrol acetate, geranial, methyl carvacrol, methylthymol, thymolmethyl ether, menthol, nerol, carvone,fenchylalcohol, carvacrol methyl ether,thymoquinone, geraniol, bornyl acetate, β -citronellol, carvacrol, geranyl acetate, linalyl acetate, terpinylacetate[30,31]
Sesquiterpene hydrocarbons	Copaene, β -bourbonene, α -elinene, γ -cadinene, calamenene, δ -cadinene, α -cadinene, germacreneD,β -abolene,epi-sesquiphellandrene,bicyclogermacrene,valencene,α -bisabolol,cis-bisabolene, α -cymene,β -cymene,β -ocinene,α -ylangene,β -longipinene,longifolene,cubebene, β -elemene, muurolene,amorphene,aromadendrene,α -humulene,allo-aromadendrene,(E)-β -farnesene,

	β -caryophyllene,isoledene,iso-caryophyllene,trans-caryophyllene,spathulenol,elemol,trans-nerolidol, caryophyllene oxide, cadrol, α -campholene aldehyde, linalylpropanoate, isopulegone, tetradecanal, trans-carbyl propionate, ethyl cinamate, geranyl butyrate, bicyclogerma, piperitol, cadrol,crene,p-mentha-1-(7),8-diene,isoborneol,cubebene,longkyclene,longifolene,isovalericacid, cis-dihydrocarvone, p-cymene-2,5-diol, β-bisabolene, heptanoic acid, hexadecanoic acid, 2-nonanone,caffeic acidethylester[30]
Others	1-octen-3-ol,3-octanol,3-octanone,3-penten-2-ol,4-methyl-2-pentanol,6-methyl-5-hepten-2-one[31]

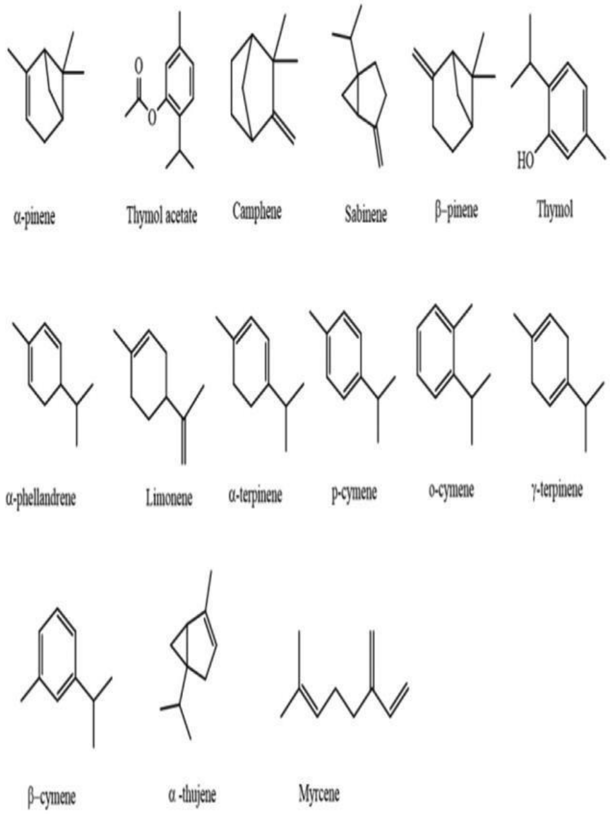
Indian state of Jammu and Kashmir. According to Aziz et al. [24], spathulenol, cyclohexane, and safrole were found in the essential oil of T. serpyllum. The researchers from Northern Kazakhstan also found a greater concentration of thymol (58.25%), transgeraniol (55.93%), lavandulyl acetate (28.51%), nerol (2.76%), and E-citral (2.58%). The primary components of the essential oil of T. serphyllum from various locations of Southern Italy were determined to be trans-geraniol, lavandulyl acetate, nerol, and Ecipitral.[25] The Thymol and carvacrol are well-known food additives that attract a lot of business due to their high concentrations and safety, as certified by the World Health Organization's food additives recommendations.[26]According to the FDA standard (www.fda.gov/downloads/ICECI/ComplianceManuals/ Compliance Policy Guidance Manual/UCM142644.pdf; accessed July 5, 2019), thymol and T. serpyllum plants may be used as spices. On the other hand, there has been a surge of interest in T. serpyllum nonvolatile secondary metabolites, such as rosmarinic acid, ursolic acid, and oleanolic acid.[27] Figures 1-4 show the two-dimensional structures of phytocompounds, while Table 1 displays the several phytoconstituents found in T. serpyllum essential.

Thymus serpyllum: A Pharmacological Tool

Extensive research has shown that T. serpyllum extracts and compounds have a wide range of biological activity, including anticancer, antibacterial, antioxidative, and anti-inflammatory properties. Additionally, new research has examined how thymol and carvacrol interact with the COVID-19 nucleocapsid phosphoprotein .[32] An additional investigation indicated that 25 phytocompounds of T. serpyllum essential oil exhibited poor binding to SARS coronavirus 2 (PDB ID: 6VYO).[32] On the other hand, suitable in vitro and in vivo trials may further validate these in silicoresearch. Some of the significant biological uses of T. serpyllum.

Features of an antioxidant

A number of investigations looked at the antioxidant capabilities of T. serpyllumextracts.The antioxidant activity of the essential oil of T. serpyllum flower tops and stalks was shown by Kulisic et al. [33] using the 2,2-diphenylpicrylhydrazyl (DPPH) technique, with an IC50 of around 0.40 ± 0.05 g/L. The antioxidant capabilities of T. serpyllum were also shown by its ethanolic and aqueous extracts, with DPPH test results indicating IC50 values of 13.2 ± 0.3 □g/ml and 31.6 ± 0.8 □g/ml, respectively.on page 34 Additionally, Mihailovic-Stanojevic reported the antioxidant activity of a water extract of T. serpyllum using the Ferric ion reducing antioxidant power (FRAP) test (IC50-16.59 ± 1.06 mM Fe (II) equivalents) and the ABTS assay (IC50-8.60 ± 0.05 mM Trolox).



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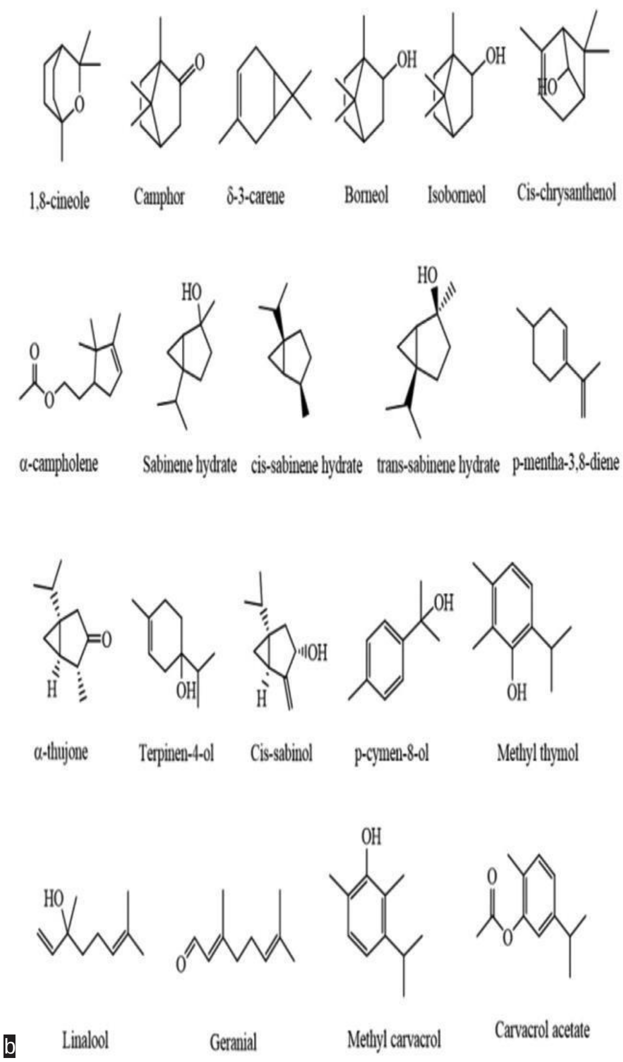
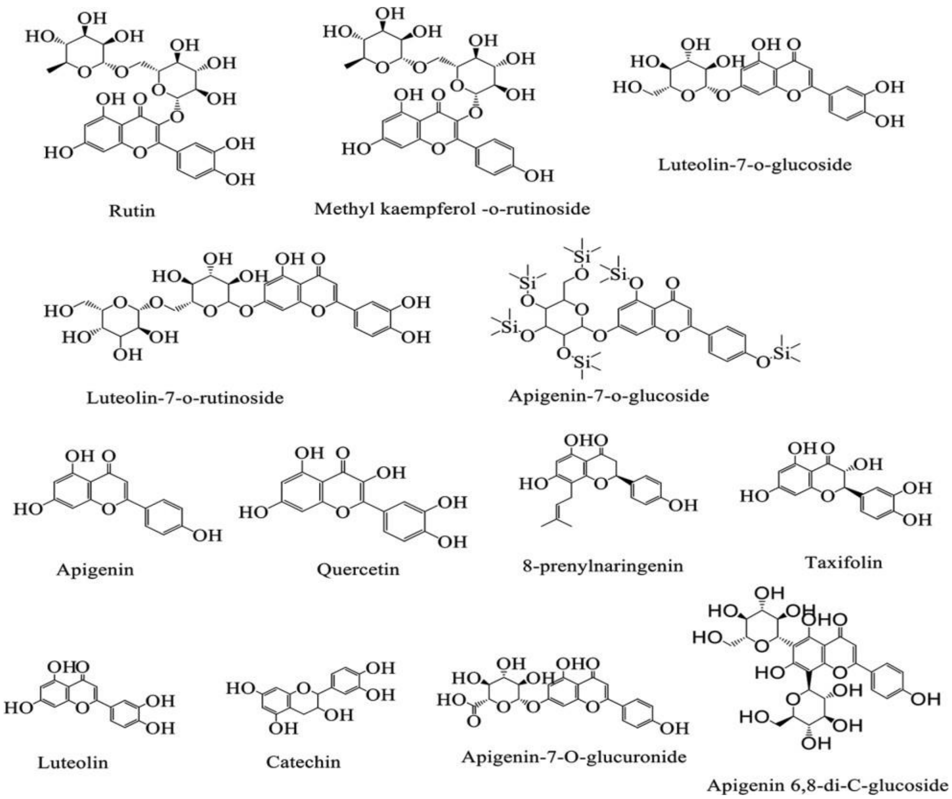


b

Figure1:2-dimensionalstructures*Thymusserpyllum*phytocompounds:(a)Monoterpenehydrocarbonspresentin*Thymusserpyl*



*lum*and(b)Oxidized

Figure2:2-dimensional structures of phenolics and flavonoids present in *Thymus serpyllum*

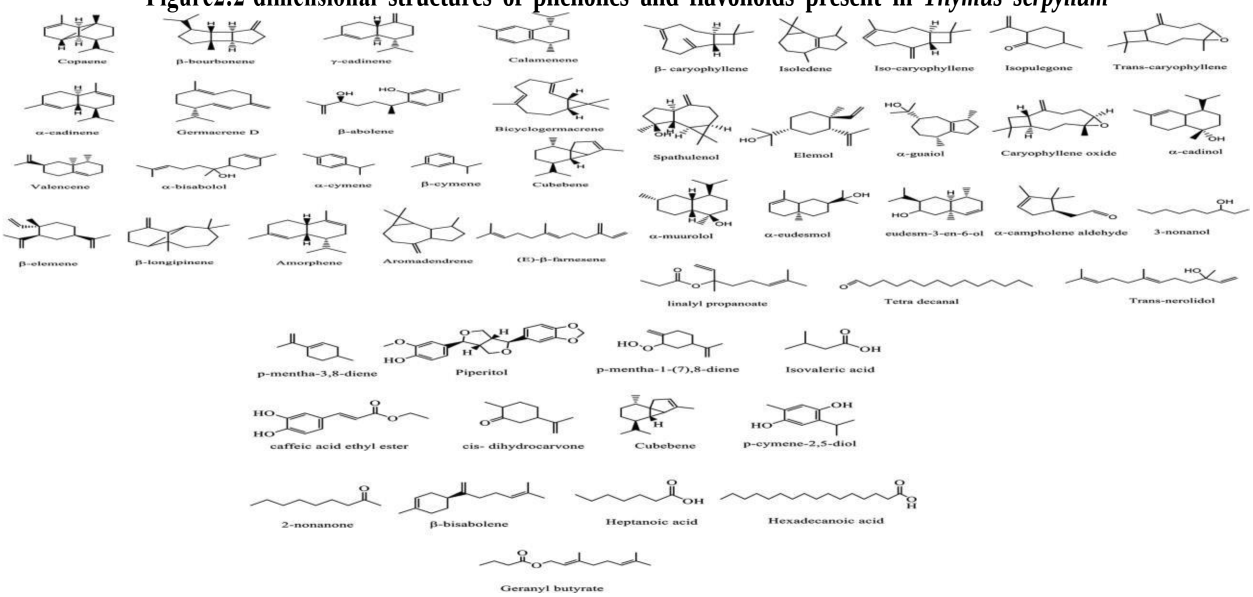


Figure3:2-dimensionalstructuresofsesquiterpenehydrocarbonspresentin*Thymusserpyllum*

with others.The free radical scavenging activity was shown with an IC50 of 3.00-3.17 mg/mL in T. serpyllum extracts that were aided by ultrasound (22). Antioxidant activity of T. serpyllum EO isolated from entire plants was also shown by Nikolic et al. [15] using the DPPH technique (IC50 0.96 g/mL). The phenolic concentration, together with the rosmarinic and caffeicacids[22], gave this plant its antioxidant efficacy.[36]

Impact on microbes

The antibacterial properties of extracts and essential oils from different T. serpyllum plants have been shown in several investigations.(15, 28, 30, 37–40) Table 1 summarizes the antimicrobial and antifungal activity. The thymol and carvacrol in T. serpyllum are responsible for its antibacterial properties, according to the research.[15] Curcumin and According to Farrukh et al., T. serpyllummethanolic and ethyl acetate extracts were found to have antibacterial and antifungal properties. These properties were tested against a variety of bacteria and yeasts, including Pseudomonas aeruginosa, Staphylococcus epidermidis, Staphylococcus aureus, Escherichia coli, Aspergillus fumigatus, Candida albicans, Candida parapsilosis, and Aspergillusniger. The minimum inhibitory concentration (MIC) ranged from 2000 g/ml to 4000 g/ml.[42] The bactericidal efficacy of T. serpyllum EO was 100% against all strains tested after 30 minutes of exposure. The EO of T. serpyllum, as described by Varga et al. [28], contains 32.2% thymol and 25.8% carvacrol. The EO has been tested in both concentrated (100%) and diluted forms.

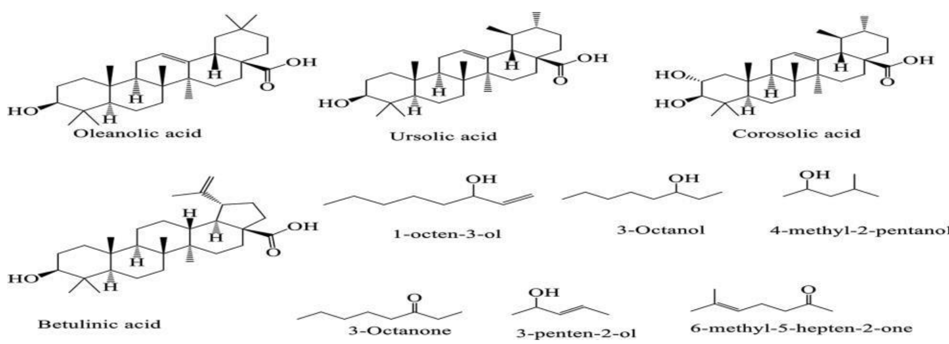


Figure 4: 2-dimensional structure of triterpenic acids and other phytocompoundsin*Thymusserpyllum*

In an agar well diffusion experiment, half of the samples tested for Cronobactersakazakii, Pseudomonas aeruginosa, Streptococcus pyogenes, Listeria innocua, Candida albicans, and Saccharomyces cerevisiae exhibited 100% cell death. The chemical and antibacterial potentials of both the main and secondary EO of T. serpyllum L. were assessed by Verma et al. [30]. There were 92.5% phenolic phytocompounds in the secondary EOs of T. serpyllum, as opposed to 42.1% in the main EO. Curiously, the secondary EO exhibited antibacterial solid action against all bacterial and fungal strains tested, with MIC values ranging from 1/3200 to 1/6400 and Ferric ion reducing antioxidant powers (ZOI) ranging from 20 to >35 mm. The combined effects of wild thyme (T. serpyllum), oregano (Origanumcompactum), and marjoram (O. majorana) essential oils were investigated by Ouedrhiri et al. [38]. They found that the combination had a practical synergistic impact ($P < 0.001$) against S. aureus germs. On the other hand, a synergistic effect against S. aureus and E. coli was shown when wild thyme essential oil and oregano were combined. The synergistic potential of EO from T. serpyllum with antifungal drugs to cure candida infections has been described recently by Salaria et al. [40]. In their study, Erci and Torlak [39] found that silver nitrate nanoparticles (AgNPs) derived from water-based T. serpyllum extracts were effective against bacteria. The area that B. cereus could not cross in the presence of AgNPs was 12.23 ± 0.54 mm. When treated against S. aureus, on the other hand, the inhibition zone measured 13.86 ± 0.58 mm. The sizes of the inhibitory zones for E. coli and S. typhimurium, respectively, were 9.98 ± 1.02 mm and 10.60 ± 0.53 mm, as measured using AgNPs. Research from these research demonstrated unequivocally the therapeutic value of essential oils and wild thyme extracts in combating microbe-borne diseases.

Impact on inflammation reduction

Kindl et al. examined T. serpyllum's anti-inflammatory response in vitro by blocking the Src tyrosine kinase and interleukin-6 production in splenocytes of Balb/c mice.[44] In contrast to polyphenols like luteolin (IC50 = 8 □M), luteolin-7-O-glucoside (IC50 = 40 □M), and rosmarinic acid, a mild dose-dependent inhibition of Src kinase was seen with T. serpyllummethanolic extract (IC50 = 115-167 □g/ml). staurosporine (a Src tyrosine kinase inhibitor) and acid (IC50-61 □M at 0.01 □M) both have IC50-0.005 □g/ml. Polyphenols and T. serpyllum extract were also tested for cytotoxic activities using the MTS assay. The generation of IL-6 was inhibited by adding T. serpyllum extract and polyphenols (200-0.8 □ g/ml). The cytokine production in the treated cells was decreased by over 95% at a high concentration of T. serpyllum (200 □ g/ml), and the IC50 value for IL-6 production was determined to be 49.5 ± 9.6 □g/ml. There was no evidence of cytotoxicity when T. serpyllum extract (200-0.8 □g/ml) was used.

Activity against cancer and cytotoxicity

The cytotoxic and anticancer properties of Thymus sp. solvent extracts, essential oils, and phytocompounds have been shown in several studies. The cytotoxic and Hep-2 activity against a mouse leukemia model was shown by Jaafari et al. [45]. In a study conducted by Nikolic et al., [15] it was shown that T. serpyllum essential exhibited anticancer properties against MCF-7, NCI-H460, HCT-15, HeLa, and others. The essential T. serpyllum showed a 50% inhibition of growth (GI 50-52.69 ± 3.28 µg/ml), GI50-37.17 ± 3.18 µg/ml), GI50-7.02 ± 0.07 ± 0.07 ± 0.07 g/ml), and GI50-17.71 ± 3.23 g/ml.

Table2:Antimicrobialactivity of extracts and *Thymus serpyllum* essential oil against different bacterial and fungal species

Part used	Extracts/EO	Method	Tested strains	Key results
Aerial parts	EO	Agarwell diffusionand brothdilution	*K.pneumoniae* *P.aeruginosa* *E. coli* *S.aureus*	15–40mm,100%bactericidalafter30minexposure. Ineffectiveagainst*P.aeruginosa*[43]

			B. subtilis	
Aerialpart	Ethanol,butanol, methanol,hexane, ethyl-acetate,and aqueousextracts	Microdilution method	*E.coli,P.aeruginosa,S.aureus, S.epidermidis,C.albicans,C. parapsilosis* *A. fumigatus* *A.niger*	Onlyethyl-acetateandmethanolicextractsexhibited significantactivityagainstalltestedbacteria andfungi, displayingMICvaluesrangingfrom 2000–4000µg/mL[42]
Whole plant	EO	Microdilution method	Ochratoxinaproducingstrains: *A.ochraceus,A.ochraceus,A. carbonarius*,and *A.niger*	MICrangedbetween0.625 and2.5µL/mL [37]
Aerial parts	EO	Agardiffusion method	*P.aeruginosa,C.sakazakii,L. innocuaandS.pyogenes,C. albicans,S.cerevisiae*	Completeinhibitionofthegrowthofallthe strainsby 50% and100% EO [28]
Aerial parts	PrimaryEO and secondaryEO	Diskdiffusion methodand microdilution method	*S.aureus,S.epidermidis,E. faecalis,S.mutans,E.aerogenes,K. pneumoniae*andpathogenicfungi: *C.neoformans*and*C.albicans*	Φ-20–>35mm MICrangedbetween1/3200and1/6400[30]
Aerial parts	EO of*T. serpyllum* incombination with EO of*O. compactum* (oregano), and*O. majorana*(marjoram)	Microdilution methodand checkerboard assay	*B.subtilis,S.aureus*and*E.coli*	Antibacterialsynergisticeffectwasobservedwith combinationof EO of*T.serpyllum*with EO of marjoramagainst*S.aureus*,whilecombinationofEO oforeganoand EOof*T.serpyllum*showedsignificant synergisticactivityagainst*S.aureus*and *E.coli*[38]
Aerial parts	EO of*T. serpyllum* incombination with EO of*O. majorana* (marjoram)	Microdilution methodand checkerboard assay	*E.coli*and*S.aureus*	SynergisticantibacterialeffectofEOof*O. majorana* and *T.serpyllum*withFICindex of 0.725[38]
Leaves	AgNPsofaqueous extracts	Agarwell diffusion	*B. cereus*	Φ-12.23±0.54mm
			S.aureus	Φ-13.86±0.58mm
			E. coli	Φ-9.98±1.02mm
			S. typhimurium	Φ-10.60±0.53mm

K. pneumoniae=Klebsiella pneumoniae, P. aeruginosa=Pseudomonas aeruginosa, E. coli=Escherichia coli, S. aureus=Staphylococcus aureus, B. subtilis=Bacillussubtilis,S.epidermidis=Staphylococcusepidermidis,C.albicans=Candidaalbicans,C.parapsilosis=Candidaparapsilosis,A.fumigatus=Aspergillusfumigatus,

A. niger=Aspergillusniger, A. ochraceus=Aspergillusochraceus, A. carbonarius=Aspergilluscarbonarius, C. sakazakii=Cronobactersakazakii, L. innocua=Listeriainnocua,S.pyogenes=Str eptococcuspyogenes,S. cerevisiae=Saccharomycescerevisiae, E.faecalis=Enterococcusfaecalis,S. mutans=Streptococcusmutans,

E.aerogenes=Enterobacteraerogenes,C.neoformans=Cryptococcusneoformans,B.cereus=Bacilluscereus,S.typhimurium=Salmonellatyphimurium,

T. serpyllum=Thymus serpyllum, O. majorana=Origanummajorana, O. compactum=Origanum compactum, Φ=Zone of inhibition in mm, MIC=Minimum inhibitoryconcentration, FIC=Fractionalinhibitory concentration,EO=Essential oil,AgNPs=Silver nitratenanoparticles

The HepG2 gene has a half-life of about 34.96 ± 2.90 µg/ml. The MCF-7, LNCaP, and NIH3T3 fibroblast cell lines were shown to be cytotoxic by T. serpyllum EO. Research indicates that the antiproliferative activities of the EO are due in part to molecules such -caryophyllene, a sesquiterpene.[46] The antiproliferative effect of the EO of T. serpyllum against oral squamous cell carcinoma cultures and the SCC-25 cell line was shown to be restricted by Lazarevic et al.[47]. With IC50 values of 95.8, 105.0, and 105.0 mg/ml, respectively, the oil exhibited comparable effects against MCF-7, LNCaP, and NIH-3T3 cell lines.[46] Berdowska et al.[48] reported that the cytotoxicity of the T. serpyllum water extract was tested against both cancer cells (MCF-7/Adr) and wild-type MCF-7 (wt) cells. Acute promyelotic leukemia (HL-60) cells were shown to have antiproliferative activity when exposed to thymol, a primary component of T. serpyllum essential oil.[49] Thymol and carvacrol exhibited cytotoxicity against breast cancer that was dosage dependant. tumors, colorectal cancer, and the P815 mastocytoma cell proliferation model. Similarly, Jaafari et al. observed that the cytotoxic activity of T. serpyllum EO was correlated with its carvacrol concentration.[45] So, it is possible to study the therapeutic usefulness of thyme essential oils and phytocompounds in treating cancer in people.

Activity against malaria

Researchers Hussain et al.[31] used an antihembiocrystallization test to look at the antimalarial effects of T. serpyllum essential oil. The antimalarial activity of T. serpyllum oil was found to be 46.1% at a concentration of 10 mg/ml. The antimalarial potential of T. serpyllum EO and its components has to be further investigated in in-depth investigations using different doses and model systems.

Safety Investigations

When taken in the approved therapeutic doses, thyme has been designated as "food safe" by the US Food and Drug Administration. Researchers Xie et al.[50] found that mice were able to breathe in thymol hydrofluoroalkane at concentrations ranging from 0.1% to 0.5% for 6 months without experiencing any negative effects on their respiratory systems or lungs. On the other hand, data about the harmful effects of T. serpyllum EO administration is few. To further understand the safety profile of T. serpyllum EO, it is essential to do comprehensive studies that concentrate on the toxicity aspects utilizing different doses and model systems.

Alternative Uses of Biotechnology

Activity of food preservatives

The phytocompounds contained in T. serpyllum EO, including as thymol, carvacrol, terpenoids, and others, have shown to be valuable in improving food safety and quality by inhibiting the development of food microorganisms. These phytocompounds either function as antimicrobials to combat food-borne diseases or inhibit the deteriorating action of bacteria in food goods.[51] Because of its antioxidant and antibacterial characteristics, wild thyme is a vital therapeutic herb.[15] Hagan et al.[52] found that fermenting cakes with T. serpyllum EO helped prevent fungal infections.

Pest control ability

Research has shown that the principal active element in T. serpyllum's essential oil, thymol, is resistant to the larvae and pupae of common houseflies (Musca domestica). New evidence suggests that T. serpyllumthymol may cause fumigant and contact toxic reactions. These results indicate that thymol and T. serpyllum EO are both poisonous to housefly larvae and pupae, which might make them useful tools for managing housefly populations. The insecticidal activities of carvacrol and thymol from T. vulgare have already been reported by Szczepanik et al. [53]. Unfortunately, the insecticidal capabilities of T. serpyllum EO have not been studied so far. But the insecticidal effect of T. serpyllum EO has not been studied before.

Environmental protection

A wide range of pharmacological effects are shown by T. serpyllum. T. serpyllum has piqued the curiosity of both scientists and the general public in the hopes of creating new herbal remedies.

Indian, Chinese, Nepalese, Pakistanese, North American, and East African cuisines mostly include T. serpyllum.[8] Because of its great medical value and scarcity of supply, scientists are attempting to grow T. serpyllum in vitro using tissue culture methods. Dear Sir/Madam RajanRolta, Advisor at TridevAushadhiUtpadhan Society, Rohal,Chirgaon,DistrictShimla,Himachal Pradesh,India,is also trying to cultivate the T. *serpyllum*in its naturalhabitattofulfilltheindustrialdemand forthisherb.

Another individual who is attempting to meet the industrial need for T. serpyllum is an advisor at the TridevAushadhiUtpadhan Society in Rohal, Chirgaon, District Shimla, Himachal Pradesh, India.

Considerations for the Future and Final Thoughts

Aerial parts of T. serpyllum have been used to treat esophageal, gastric, and urinary tract infections. Essential oils from this species have become more popular in contemporary medicine because of their pharmacological significance. Important for industrial, cosmetic, and medicinal uses, the phytocompound composition and yield of T. serpyllum EO are affected by a number of variables, including as growth stage, geographical location, and harvesting season. New studies show that T. serpyllum essential oil has powerful antibacterial and antioxidant effects. The possible use of thymol, carvacrol, and other components against cytotoxicity, inflammation, malaria, and hypertension needs more research, however. The herb's varied pharmacological effects make it valuable to the pharmaceutical business, while its potential antioxidant and nutritional supplement uses make it attractive to the food industry.

References:

1. Tulsi (Ocimum sanctum Linn) and its medicinal benefits, including a brief overview of eugenol and its pharmacological effects, by Prakash P and Gupta N. Indian

Journal of Physiology and Pharmacology, 2005, 49: 125–131.

2. The Traditional Medicine Strategy of the World Health Organization from 2002 to 2005. Publishing: Geneva, Switzerland: World Health Organization (WHO); 2002. WHO/EDM/202. 1.

3. The authors of the article include Harley RM, Atkins S, Budantsev AL, Cantino PD, Conn BJ, Grayer R, and others. Labiatae family. Section: Dichotoledons (Flowering Plants). Springer Berlin, Heidelberg, 2004. Pages 167–275.

4. Baritaux, Richard H., Bejilali B., and Banquoir, N. O. Analyzing the several Moroccan thyme essential oils. "Landeskrankheitstechnologie in Lebensmitteln" (1985): 105–10.

5. This is the fifth work by Cornara, La Rocca, Marsili, and Mariotti. Plants and their traditional applications along Italy's Liguria coast. In 2009, the Journal of Ethnopharmacology published an article with the DOI 125:16-30.

6. Sixth, Rowshan, Bahmanzadegan, and Saharkhiz MJ. Thymus daenensiscelak essential oil composition as affected by storage conditions. Retrieved from "Ind Crops Prod" (2013), volume 49, pages 97 to 101.

7. Sáez F. and Stahl-Biskup E., editors. One species of thyme is Thymus.

8. Section 300 of Taylor & Francis Group's 6000 Broken Sound Parkway NW The authors of the manuscript are Jarić, Mitrović, and Pavlović. Evid Based Complement Alternat Med (2015): 101978: A review of ethnobotanical, phytochemical, and pharmacological studies on Thymus serpyllum L.

9. In 2001, Zhu published an article in Trends in Plant Science, volume 10, pages 1360–1385.

10. Ramiro-Sharifi, Jaszaruk, Polito, Morais-Braga, Rocha, Coutinho, et al. Antimicrobial compounds derived from the Matricaria genus: agricultural, pharmaceutical, and culinary uses. "Microbiological Research" published in 2018 with the DOI 215:76–88.

11. Eriksson Ä. Thymus serpyllum regional distribution: limits on dispersion and history of management. Ecography, 1998, vol. 21, pp. 35–43.

12. Heilmeyer, M. Herbs of antiquity. Address: 1200 Getty Centre Drive Suite 500, Los Angeles, California 90049-1682, ISBN-13:978-0-89236-884-6, published by Getty Publications in 2007.

13. Karaharova E, Lebanova H, Getov I, Benbassat N, and Napier J. were the authors of the article. A descriptive examination of the current state of Bulgarian traditional medicinal plant knowledge. Published in 2013 by Afr J Pharm Pharmacol, the journal has a focus on pharmaceutical research.

14. This is the fourteenth work by Dandlen, Miguel, Duarte, Faleiro, Sousa, Lima, and others. Portuguese thymus essential oils reduce acetylcholinesterase activity. Journal of Essential Oil Bearing Plants 2011;14:140-50.

15. The authors include Nikolaić, Glamočlija, Ferreira, Calhelha, Fernandes, Marković, and others. Thymus serpyllum L. and Thymus algeriensisBoiss chemical

composition, antibacterial, antioxidant, and anticancer properties.

16. Reut and Thymus vulgaris L. essential oils, moreover. The authors of the article "Ind Crops Prod 2014;52:183-90" are Mustafa B, Hajdari A, Krasniqi F, Hoxha E, Ademi H, Quave CL, and sixteen others.

17. Albatian Alps ethnobotany for medicinal use in Kosovo. In a 2012 article published in the Journal of Ethnobiology (Ethnomed), the authors (Mustafa, Hajdari, Pieroni, Pulaj, Koro, and Quave) discussed. Folk plant usage among Albanians, Bosniaks, Gorani, and Turks in south Kosovo: a cross-cultural comparison. The article "J EthnobiolEthnomed 2015:11:39" was published in 2015.

18. The authors are Gairola, Sharma, and Bedi. An examination of medicinal plant use in Jammu & Kashmir, Ladakh, and India from a cross-cultural perspective. Journal of Ethnopharmacology 2014;155:925–86.

19. The authors of the study are Carrió, Rigat, Garnatje, Mayans, Parada, and Vallès (19). Comparison of plant ethnoveterinary techniques with human ethnobotanical medicine in two Balearic island regions and two Pyrenean territories of Catalonia (Iberian Peninsula). Reference: Evid Based Complement Alternat Med 2012;2012:896295.

20. Zarzuelo A and Crespo E. 20. A look into thyme's applications, both medical and otherwise. As published in Thyme in 2002. (pg. 277–306) CRC Press eBook with the ISBN 9780429218651.

21. Research on the chemical components of Thymus serpyllum (Aziz S., n.d.).“Turkish Journal of Chemistry” 2008; 32: 605–14.

22. The authors of the article are Mihailovic-Stanojevic N, Belšĉak-Cvitanović A, Grujić-Milanović J, Ivanov M, JovovićDj, Bugarski D, along with others. Thymus serpyllum L. extract's antioxidant and antihypertensive effects in a controlled laboratory setting. The article is published in the Plant Foods Hum Nutr journal and has the citation: 2013;68:235-40.

23. Genetic polymorphism in thyme: population structure and regional dynamics (Thomson, J.D.). Found in Thyme 2002: pages 58–88. Copyright © CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 334872742.

24. Irshad M, Aziz S, Hussain H, Habib-ur-Rehman, Habib-ur-Rehman, Ahmed I. Essential oils of Thymus serpyllum cultivated in Jammu and Kashmir: phytotoxic and antifungal effects. The citation is from the 2010 Journal of Essential Oil Bearing Plants, volume 13, pages 224–249, page

25. The authors of the article are Kirillov V, Stikhareva T, Mukanov B, Chebotko N, Ryazantsev O, Atazhanova G, and Adekenov S. The chemical make-up of the Thymus serpyllum L. essential oil sourced from the northern region of Kazakhstan. Article published in 2016 in the Journal of Essential Oil Bearing Plants, volume 19, pages 212–22.

26. The authors of the article are Stahl-Biskup E and Venskutonis RP. I love thyme. The Herbal Remedieswith seasonings, Page number: 499-525 from Taylor and Francis Group's 2012 publication by Woodhead Publishing, located at 6000 Broken Sound Parkway NW, Suite 300 in Boca Raton, FL.Yan X, Fan S, Li X, Wang X, Shen M, He T, and others.

27. Plants belonging to the genus Thymus and its traditional applications, chemical components, and biological activity. The article is published in the journal Chemistry & biodiversity and has the DOI: 1900254.G.

28. Horvath, A. Bardocz, B. Boros, E. Varga, A. Maraz, A. Belak, and A. Felinger. Analysis of the chemical make-up, antimicrobial properties, and polyphenolic content of various Thymus extracts, as well as essential oils of thyme. The journal Thymus published an article in 2015 with the DOI: 0.6363.

29. Saudone L, Raudonis R, Gaivelytė K, Vainorienė R, and Janulis V were the authors of the 29th publication. Phenolic and triterpene profiles of Thymus vulgaris species grown in a controlled environment. The sentence is a collection of abstracts from an international symposium on phytochemicals that took place from September 17th to the 19th, 2017 in Francavilla al Mare, Chieti, Italy. The symposium was organized by the Italian Society of Phytochemistry and Medicinal and Food Plant Sciences, and it was written by Profumo and others. Chieti CH: "G. d'Annunzio" Department of Pharmacy Chieti-Pescara, 2017.

30. With the help of Rahman LU, Verma RK, Singh A, Yadav A, Chanotiya CS, and others..... Thymus serpyllum essential oil blend from the Kumaon area of India's western Himalayas. Journal of natural products. 2009;4:1934578X0900400723.

31. The authors of the report are Hussain AI, Anwar F, Chatha SA, Latif S, Sherazi ST, Ahmad A, Worthington J, and Sarker SD. Investigations on the bioactivity and chemical makeup of two essential oils extracted from Thymus species native to Pakistani plants. The article "LWT—Food Science and Technology" was published in 2013 in volume 50, pages 185–92.

32: Rolta R, Yadav R, Salaria D, Trivedi S, Imran M, Sourirajan A, and others. One way to stop the COVID-19 virus from assembling is to use in silico screening to find one hundred phytocompounds from ten medicinal plants that might block the virus's nucleocapsid phosphoprotein. "Journal of Biomolecular Structural Dynamics" published in 2021, volume 39, pages 7017–34.

33. Kulismic T, Radonic A, Milos M. Essential oil fractions inhibit lard oxidation. Grasas y Aceites 56.285–291 (2005).

34. Mata AT, Proença C, Ferreira AR, Serralheiro ML, Nogueira JM, and Araújo ME came up with the formula. Five plants used as spices in Portuguese cuisine were tested for their antioxidant and antiacetylcholinesterase effects. Published in 2007 in the Journal of Food Chemistry, volume 103, pages 778–78.

35. The authors of the article are Jovanović A, Đorđević V, Zdunić G, Šavikin K, Pljevljakusić D, and Bugarski B. Exploring the antioxidant activity of Thymus serpyllum polyphenols using ultrasound-assisted extraction. The journal HemijskaIndustrija published an article in 2016 with the DOI number 70: 391–90.

36. The authors of the article are Hazzit, Baaliouamer, Veríssimo, Faleiro, and Miguel. The chemical make-up and biological effects of thymus oils from Algeria. Scientific American, 2009, 116, 714–721.