

Phytochemical and Pharmacological Study of *Thymus Vulgaris* : A Review

Mohd Zubair Ashraf¹, S. Ramasamy²

¹Department of Pharmacy, MJP Rohilkhand University, Bareilly, Uttar Pradesh, India

¹ORCID ID - 0009-0002-9322-3803

²Associate Professor/ Department of Pharmacy/MJP Rohilkhand University, Bareilly, Uttar Pradesh, India

ARTICLE INFO

Article History:

Accepted : 10 July 2024

Published : 29 July 2024

Publication Issue :

Volume 11, Issue 4

July-August-2024

Page Number :

190-201

ABSTRACT

The thymus vulgaris is a kind of flowering plant native to southern Europe, ranging from the western part of the Mediterranean to southern Italy. It is additionally referred to as gardening thyme, German thyme, ordinary thyme, or simply thyme. The Lamiaceae family of mints includes it. Because it can be used in so many different products—including additives for food, medicines, and cosmetics—thyme is incredibly significant. Thyme leaves are used as aromatic spices, either dried or fresh, in various cooking applications, including stews, soups, sauces, and fish and meat dinners, as well as for flavouring liqueurs and herbal beverage preparations. This is because of the leaves' strong aroma. Bitter, diuretic, antioxidant, antirheumatic, disinfectant, antispasmodic, antimicrobial, heart, and expectorant properties are a few of thymus's therapeutic advantages, a noteworthy medicinal herb that comes strongly suggested. In addition, the plant helps with digestive problems, diabetes, chest infections, coughs, and colds. Flavonoids have promising properties as both antioxidants and antifungal agents. The current review article provides in-depth details on the thymus plant's pharmacological properties and variety of phytochemical.

Keywords : - Thymus Vulgaris, Phytochemical, Pharmacological Activities, Therapeutic Effect, Pharmacognosy.

I. INTRODUCTION

Thymus vulgaris is also called 'common thyme' this standard cultivar is extensively cultivated in numerous nations, with a particular emphasis on Mediterranean regions such as Greece, Italy, and Spain.¹ 'Argenteus' (Silver Thyme) The UK and other European countries are particularly fond of this

variety, which is distinguished by its silver-edged leaves. 'Narrow-Leaved French' The name of this variety implies that it is frequently associated with France. It is frequently employed in French cuisine and is characterized by its narrower leaves and strong and fragrant fragrance.² 'English Wedgewood' The UK is a popular destination for this variety, which is recognized for its compact growth. 'German Winter'

it is particularly resilient and is associated with Germany. Its capacity to endure frigid climates is widely recognized. 'Italian Oregano' a variety that is frequently linked to Italian cuisine, this one combines the flavors of oregano and thyme. It is an annually growing grass in the Lamiaceae family (mint family).³ Thyme is widely grown for its cooking, medical, and decorative uses. The plant usually grows to a height of 15-30 cm (6-12 inches) and features small, aromatic, gray-green leaves and groups of tiny, tube pink or purple flowers that bloom in the summer.⁴ Thyme likes well-drained soil and full sun, making it a hardy and low-maintenance addition to herb beds.⁵ Its toughness and flexibility have made it a staple in different foods and plant practices around the world.⁶ In the kitchen, thyme is valued for its strong, earthy taste and is often used to season meats, soups, stews, and veggies.⁷ It is a key ingredient in many herb mixes, such as bouquet garn and herbs de Provence. Medically, thyme has been used traditionally for its cleansing, antifungal, and antibacterial qualities, largely credited to its essential oil, which includes thymol and carvacrol.⁸ The plant also draws pollinators like bees, making it useful for gardening.⁹ Thyme is extensively used as a seasoning in a diverse range of culinary preparations, such as meats, soups, stews, sauces, and vegetable dishes. The strong taste of this ingredient complements other herbs and spices well.¹⁰ Thyme essential oil, namely thymol, is used as a culinary flavoring agent, providing a robust and earthy taste. Thyme leaves may be used to prepare herbal tea, which is valued for its fragrant and calming properties.¹¹ Thymol, the essential oil found in thyme, has potent antibacterial effects and is often used in mouthwashes and antiseptic ointments.¹² Thyme has historically been used for its expectorant characteristics to address respiratory ailments, including coughs, bronchitis, and chest congestion. Thyme is said to provide digestive benefits and may be used to alleviate digestive problems such as bloating and indigestion. Thyme oil has antibacterial characteristics and may be used for the treatment of

fungal infections and other microbial ailments.¹³ Thyme contains compounds that have anti-inflammatory properties, which may help relieve symptoms associated with inflammatory disorders. Thyme is a popular plant for herb gardens owing to its resilience and ability to grow in diverse situations. It may be utilized as ground cover or in rock gardens.¹⁴ Thyme's tiny, beautiful leaves and blooms make it an appealing option for borders and container gardening.¹⁵ Thyme oil may be used as a natural pesticide owing to its insect-repellent characteristics.¹⁶ The essential oil of thyme is utilized in aromatherapy for its relaxing and stress-relieving effects. Thyme may be dried and used in handmade potpourri and sachets to offer a pleasant aroma to homes and closets.¹⁷



Fig. 1- *Thymus vulgaris* plant ¹⁸



Fig. 2- *Thymus vulgaris* flower ¹⁹

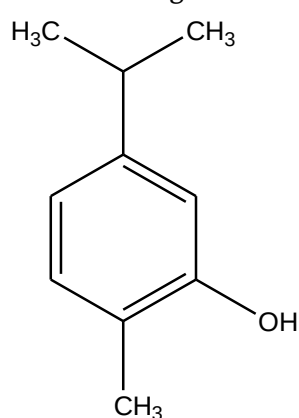
Phytochemical constituents of *Thymus vulgaris*

Numerous diverse chemical substances, including as the saponins the tannins, flavonoids, which alkaloid substances, terpenoids that and steroid hormones are

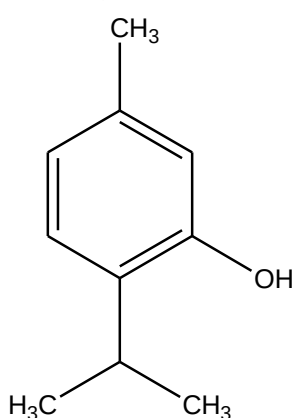
found in the vulgaris shrub L. One of the main herbs that yield monoterpene phenolic chemicals was thyme. Carvacrol, which p-cymene, -pinene, borneol, thymol, and 1, 7-cineole represent a few of their main components.²⁰ Heidari et al.²¹ employing Gas Chromatography-Mass Spectrometry (GC-MS) to identify the creosol 1-methoxy-3-methyl-phenol, thio-phenol (benzene thiol), loliolide, 8-methoxy-7-methylphenol, and quininic acid, as demonstrated within Figure 3²¹.

Thyme has a comparable abundance of flavonoids (fig. 4). Leadenin, 6-hydroxyluteolin, luteolin, which and methyl-flavones including 6-demethylnobiletin, 8-

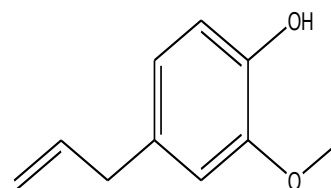
methoxy-cirsilineol, cirsimaritin, and 8-methoxy-luteolin are the main flavones. Gardenin B, which is the thymonin, siderito-flavone, and xanthomicrol are some more important flavones.²² According to Rubey et al.²³, a methanolic fraction of the species *T. vulgaris* comprised the phenolic acids (caffeic acid, a compound called p-coumaric acids, rosmarinic acid ferulic acid, and quinic acid, carnosic acid, as well as caffeoylquinic acid), nicotine (quercetin-7-O-glucoside), as well as flavanones that the apigenin (fig. 5).



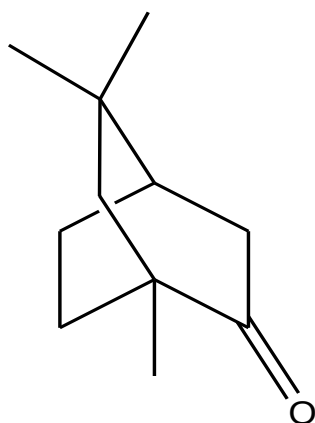
Carvacrol



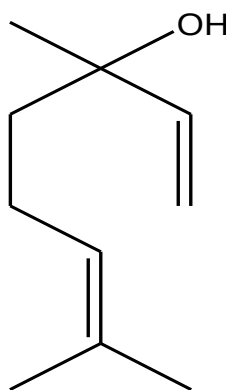
Thymol



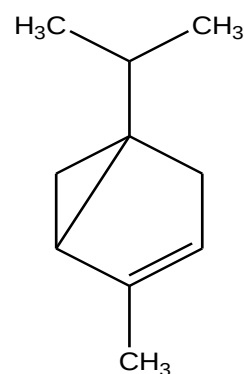
Eugenol



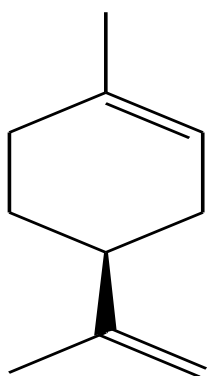
Camphor



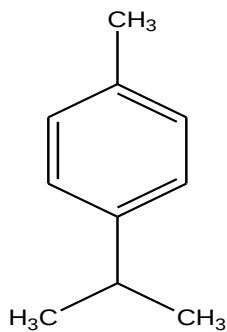
Linalool



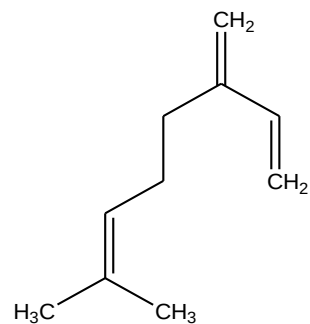
α -thujene



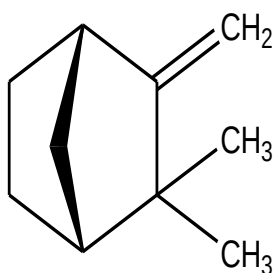
Limonene



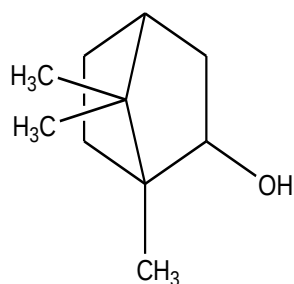
p-cymene



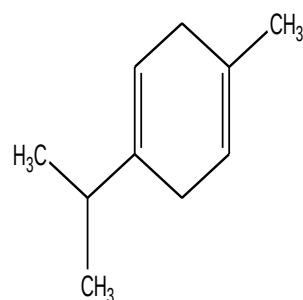
β-myrcene



Camphene

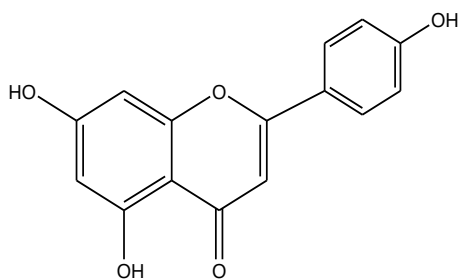


Borneol

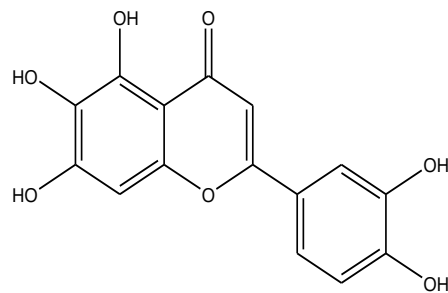


Terpinene

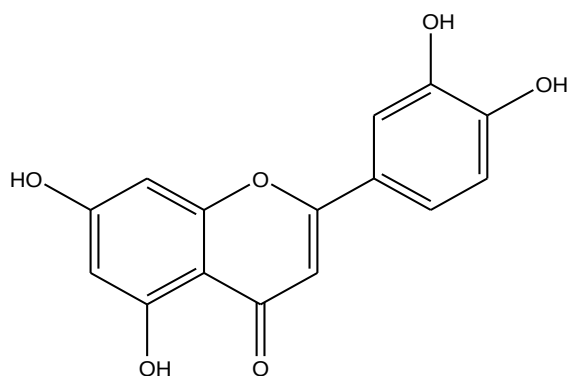
Important essential oil components of *Thymus vulgaris*



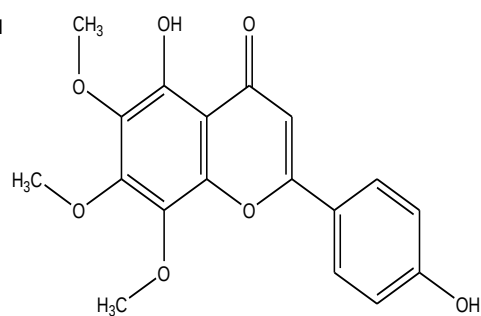
Apigenin



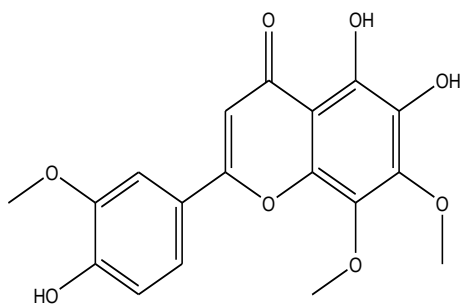
6-hydroxyluteolin



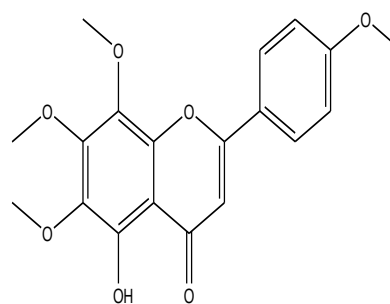
Luteolin



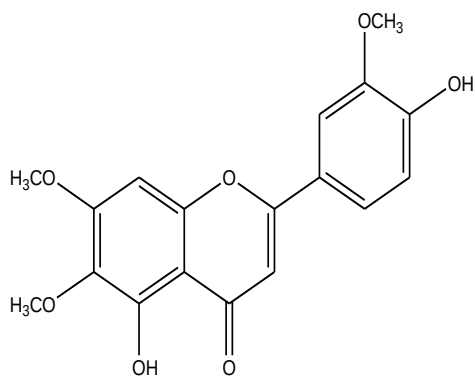
Xanthomicrol



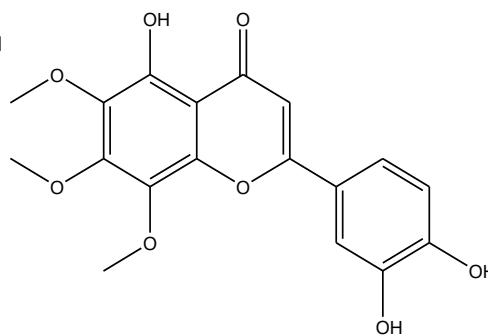
Thymonin



Gardenin B

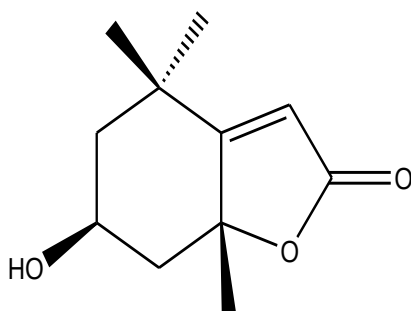


Cirsilineol

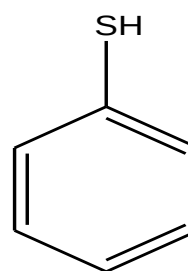


Sideritoflavone

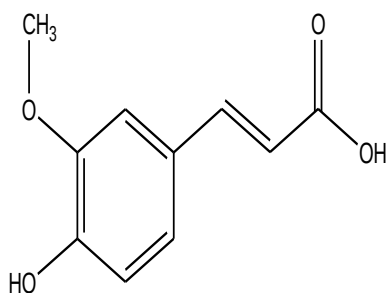
Fig. 4- Important flavonoids of *Thymus vulgaris*



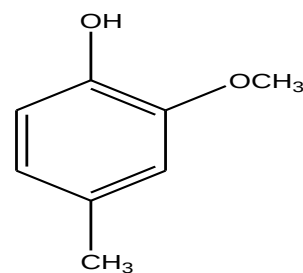
Loliolide (monoterpene lactone)



Thiophenol (benzenethiol)



Ferulic acid



Creosol 2-methoxy-4-methylphenol

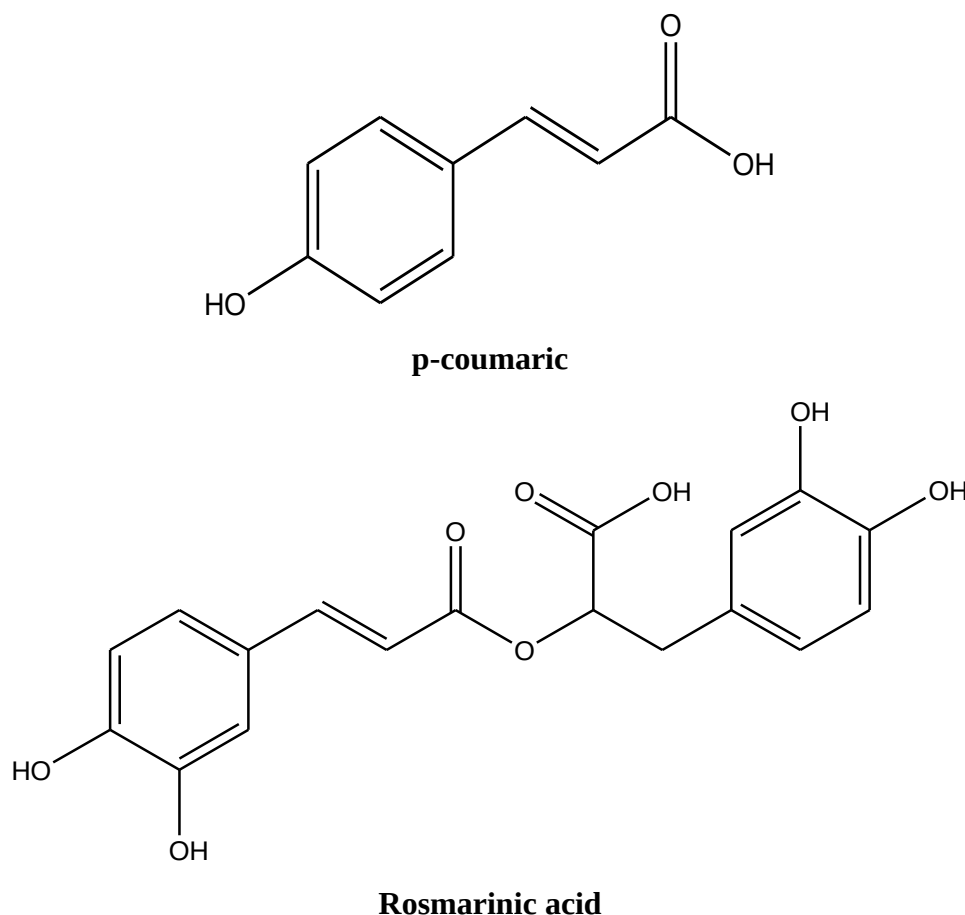


Fig.5- Important phytochemical compound of Thyme

With an array of 42.6 percent to 578.8% based on the time and location of collection, thymol is a substantial component of oil. Other components include ²⁴ trans-cimene, γ -terpinene, limonene, α -pinene, α -thujene, α -cymene, and β -myrcene. In accordance with Prasanth et al. ²⁵ the volatile oil of the plant *Thymus vulgaris* contains modest amounts of sesquiterpene hydrocarbons (5.04%), the monoterpene hydrocarbons (28.69%), and sesquiterpenes that are oxygenated (1.84%) and a substantial amount of oxygen-rich mono terpene (56.53%). Of the components of the essential oil, the compound thy accounted for 51.34% of the total, while the remaining components made up a little over a percentage of 19% I me louane et al. ²⁶ categorized the components of the essential oil of *Thymus vulgaris* into five groups: monoterpene hydrocarbons, sesquiterpene petroleum products, oxygen-rich chemical compounds and others as well. A GC and a

GC-MS investigation showed 41 constituents in the thyme essential oil, accounting for 97.85% of all detected compounds. The main compounds of the oil are eucalyptus (39.39%), camphene (17.57%), -pinene (9.55%), one, 8-cineole (5.57), the borneol (5.03%), and beta-pinene (4.32%). Further components were

present, although not to the extent of more than 2%. Thyme essential oil mostly contains camphene, -alpha-pinene, beta-pinene, and myrrh, which are monoterpene hydrocarbons. More specifically, 54.82% of all chemical groups in the oil were saturated monoterpenes. Thyme is a wonderful provider of vitamins.²⁷ It is very high in vitamins C and A. While vitamin C offers protection against viral illnesses, vitamin A has antioxidant properties. Additionally, it is an excellent source of pyridoxine, or vitamin B6, which has anti-stress properties. This plant has also been claimed to contain trace amounts of folic acid,

vitamin E, and vitamin K.²⁸ Minerals including potassium, calcium, iron, manganese, magnesium, and selenium are all abundant in thymus leaves. Minerals are necessary for healthy development.

Pharmacological activities

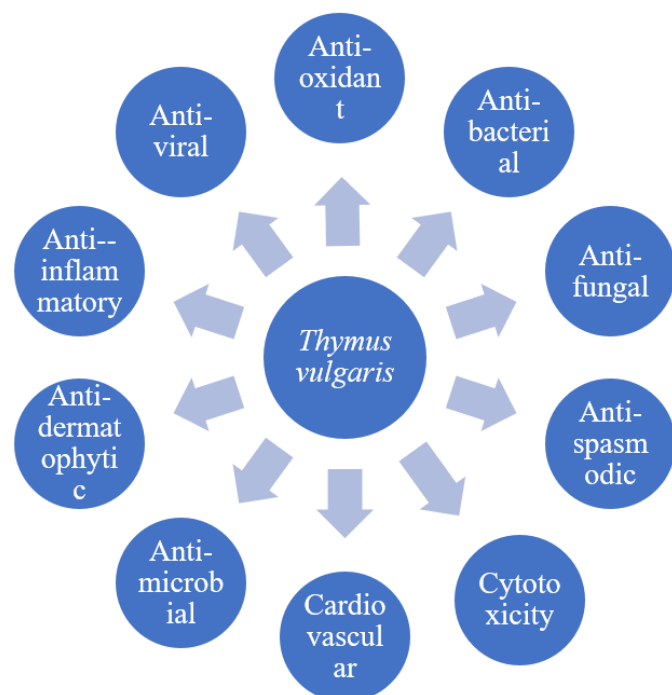


Fig. 5 - Various pharmacological activities

Antioxidant Activity

According to research on liver cells, experimental mice given extracts of thyme or sage showed increased resistance to oxidative stress. The results show that consuming extracts from *Thymus vulgaris* and *S. officinalis* increases the rat liver cells' ability to withstand oxidative damage and may have liver-protective effects.²⁹ The study looked at the quantity and composition of plant extracts, their capacity to stop hydrogen peroxide- and 2,3-dimethoxy-1,4-naphthoquinone-induced damage to DNA, and the concentrations of antioxidants that are enzymatic and non-enzymatic in human HepG2 cells, such as peroxidase from glutathione, glutathione, and superoxide dismutase. According to the findings, pretreating the cells with the investigated plant extracts significantly reduced the amount of

oxidant-induced damage to the DNA in the cells. The measured DNA-protective effect may be explained by the antioxidant properties of SO and TV as well as the increased GPx activity present in cells that were pre-treated with them.³⁰ The study evaluated the effects of thyme and spirulina dietary supplements on the quality of the flesh of rabbits, its ability to withstand oxidative degradation, and its true preservation of nutrients. The results demonstrated that while spirulina supplementation increased the quantity of linolenic acid in rabbit meat, thyme improved the resistance to oxidation in both raw and frozen meat.³¹ The effects of shortwave ultraviolet (UV-C) exposure on the antioxidant properties of thyme were studied. The decomposition rate of the UV-C treatment and untreated specimens did not vary significantly at the same concentration.³² The consequences of improving rabbit meat with algae and thyme during retail exposure was investigated. The samples classified as C-T and T exhibited the least degree of oxidation of lipids and the highest levels of tocopherol, and n-3 fatty acids in their tissues. The two types furthermore showed a substantial drop in drip loss.³³ The analysis of the antioxidant activity (AA) and whole phenolic substances (TPC) content of extracts made from powdered fresh thyme (FT) and depleted thyme (DT) indicates that an enzymatic method is a viable substitute for preparing antioxidant compounds from DT.³⁴

Antibacterial Activity

Thyme essential oils have antibacterial properties. The 2017 research by Oramadike E et al. evaluated the antibacterial activity and resistance of several antibiotics, including parahaemolyticus and fluvialis that were recovered from shrimps. As shown by the findings, the ethanol extract exhibited 20 antibacterial activities in the test and a 23 mm zone of inhibition against Parahaemolyticus and Fluvialis. *Thymus vulgaris* intervened and totally blocked the microbial load in 150 and 60 minutes.³⁵

Antifungal Activity

In chronic experimental toxoplasmosis, the potential effectiveness of *Thymus vulgaris* ethanolic extract against *Toxoplasma gondii* infection was evaluated. It was revealed that the aberrant lesions in the brain and retina were greatly improved. The findings suggest *Thymus vulgaris* potential efficacy as a new natural therapeutic and preventative agent for the treatment of chronic toxoplasmosis.³⁶

Antispasmodic Activity

Begrow *et al.* investigated two different thyme extract arrangements: one with very little concentration of the carvacrol and other with a normal amount of the thymol. We additionally looked at both carvacrol and thymol individually. These comprised functional tests on the ileum including the trachea, two distinct organs, and ex vitro clearance of mucociliary tissue (velocity of ciliary transport). Thymol and carbavacrol are effective in smooth muscle tissues such as the rat the ileum or the trachea despite the kind of activation (Ba's++, K+, or acetylcholine). Utilising endothelin or Ba++ as stimulant medications, thyme extracts with a the thymol concentration less than 40% decreased contractions, suggesting that the thymol is not the primary constituent of interest.³⁷ Micucci *et al.* research was to thoroughly look into the anti-spasmodic and gastrointestinal spasmolytic effects of a novel thyme vulgaris essential oil mixture. Solid additives were mixed with liquid essential oil to make this composition. The intestines and colon of the guinea pigs were used in an ex vivo environment to study. Assessing the results with fluid essential oil with excipients yielded different conclusions. Sensitivity to additives allowed both solid-linked essential oil to contract normally, but the essential oil's use proved more effective in reducing the colon's or ileum's baseline contractility. Neither the liquid essential oil nor the solid form of *T. vulgaris* exhibited soothing effects in K+-depolarized gastrointestinal muscle tissues in the intestinal tract and stomach.³⁸

Cytotoxicity Activity

Miladi *et al.* the essential oils of *Thymus vulgaris* and *Rosmarinus officinalis* were tested for their in vitro cytotoxicity effects on the A549 human respiratory epithelial cell line. Using the 3-(4, 5-Dimethylthiazol-2-yl)-2, 5-Diphenyltetrazolium Bromide (MTT) colorimetric test, cytotoxicity was assessed. The A549 cell line was not cytotoxicity to these extracts at any of the tested doses, according to dose-dependent tests that showed IC50 values of 8.50 ± 0.01 µg/ml and 10.50 ± 0.01 µg/ml after 72 hours.³⁹ The antibacterial and cytotoxicity properties of petroleum ether, chloroform, and hydroalcoholic extracts of thymus leaves that were harvested in Oman were investigated by Al-Balushi *et al.* the cytotoxicity activity was estimated using a brine shrimp assay. Almost all of the shrimp larvae have been destroyed by petroleum ether and chloroform extracts at greater doses of 1000 µg/ml. The two extracts' respective lethal concentrations (LC50) were determined to be 85.2 and 95.8 µg/ml. extremely low cytotoxicity activities were shown by polar components such as hydro alcoholic extract.⁴⁰

Cardiovascular Activity

Ramchoun *et al.* examined the impact of water-based extracts of *Thymus vulgaris* on the amount of antioxidants, hypotriglycerides, and high cholesterol levels. The FRAP test, the radical-scavenging technique, and the reduction of 2, 2'-azobis (2-amidinopropane) hydrochloride-induced reactive RBC hemolysis were implemented to evaluate the antioxidant potential of polyphenol-rich solutions. To induce high cholesterol among the rats, an intraperitoneal medication of 200 mg per pound of body weight drug Triton WR-1339 was injected. The plasma concentrations of overall cholesterol and triglycerides were not significantly altered after a 24-hour therapy with a thymus vulgaris extract that contained polyphenols.⁴¹

Antimicrobial Activity

The study looked at the antibacterial properties of essential oils extracted from thyme, sage, and oregano

seeds grown under various conditions. The antibacterial effects of the essential oils extracted from aromatic herbs grown under water compared to those produced without showed significant differences.⁴²

Antidermatophytic Activity

Sokovic *et al.* examined how thymus oil inhibited human pathogenic fungus such as *Trichophyton tonsurans*, *Trichophyton rubrum*, and *Trichophyton mentagrophytes*. Thymol and *Thymus vulgaris* essential oil diluted to 1%, together with the brand-name drug bifonazole, were tested for therapeutic effectiveness. Following a 37-day monitoring period, all animals recovered.⁴³

Anti-inflammatory Activity

Vigo *et al.* thyme oil decreased, in a dependent on dose way, the production of nitrogen oxide in a murine macrophage cell line via endotoxin and interferon-gamma. They proposed both their nitric oxide metabolism and their inhibitory impact on the replication of the gene that encodes an inducible synthase of nitric oxide might be the reason for the reduction in net nitric oxide generation. The key ingredient that has anti-inflammatory effects is thymol.⁴⁴

Anti-viral Activity

Rezatofighi *et al.* evaluate *Thymus vulgaris* extracts in Ovo adjacent to the Newcastle's illness virus. The maximal non-toxic concentration was obtained by performing an egg toxicity experiment on embryonated eggs. The extract capacity to lessen the viral potency by more than 56 times was shown by the inhibition percentage of 10, which was found to be 1.75.⁴⁵ Nolkemper *et al.* looked at the Herpes The effects of water-soluble extracts of plants in the Lamiaceae genus that suppress the simplex systems virus (HSV). The thymus vulgaris extracts had an inhibitory impact on HSV-1, which which is type 2 (HSV-2), or an acyclovir-resistant form of HSV-1, was evaluated by in vitro testing on the RC-37 cells utilizing the mechanism of plaque removal test.⁴⁶ Kaewprom *et al.* examined the antiviral effects of hydrosols of *Thymus vulgaris* and *Nepeta cataria*

versus a pathogenic virus which harms pork's reproductive organs and lungs. They discovered a substantial decrease in the Pork Reproduction & Pulmonary Disease Virus (PRRSV) burden via this thymus vulgaris hydrosol. Both pre-entry & post-entry phases showed anti-PRRSV action.⁴⁷

II. CONCLUSION

Thymus vulgaris it highlights that the article offers thorough details on the thyme plant's many phytochemical and pharmacological characteristics. The previous result shows the significance and worth of the review in understanding the medical and therapeutic advantages of thyme, has shown potential in inhibiting bacterial growth, reducing oxidative stress, and modulating inflammatory responses. Thyme exhibits protective effects on the liver and has been noted for its potential in treating respiratory conditions due to its antitussive and expectorant properties, encompassing an extensive array of impacts including antibacterial, antifungal, and antioxidant characteristics, treating various ailments, underscoring its importance in both traditional and modern medicine among other outcomes.

III. REFERENCES

- [1] Schwarz, K., Ernst, H., & Ternes, W. Evaluation of Antioxidative Constituents from Thyme. *Journal of the Science of Food and Agriculture/Journal of the Science of Food and Agriculture*, 70(2), 217–223. (1996). [https://doi.org/10.1002/\(sici\)1097-0010\(199602\)70:2](https://doi.org/10.1002/(sici)1097-0010(199602)70:2)
- [2] Ibrahim, T., Alayan, H., & Mowaqet, Y. A. The effect of Thyme leaves extract on corrosion of mild steel in HCl. *Progress in Organic Coatings*, 75(4), 456–462 (2012). <https://doi.org/10.1016/j.porgcoat.2012.06.009>
- [3] Stojanovic, R., Belscak-Cvitanovic, A., Manojlovic, V., Komes, D., Nedovic, V., &

- Bugarski, B. Encapsulation of thyme (*Thymus serpyllum* L.) aqueous extract in calcium alginate beads. *Journal of the Science of Food and Agriculture/Journal of the Science of Food and Agriculture*, 92(3), 685–696. (2011). <https://doi.org/10.1002/jsfa.4632>
- [4] Hoseini, S. M., & Yousefi, M. Beneficial effects of thyme (*Thymus vulgaris*) extract on oxytetracycline-induced stress response, immunosuppression, oxidative stress and enzymatic changes in rainbow trout (*Oncorhynchus mykiss*). *Aquaculture Nutrition*, 25(2), 298–309.(2018). <https://doi.org/10.1111/anu.12853>
- [5] Lee, M. H., Seo, H., & Park, H. J. Thyme oil encapsulated in halloysite nanotubes for antimicrobial packaging system. *Journal of Food Science*, 2017 82(4), 922–932. <https://doi.org/10.1111/1750-3841.13675>
- [6] Lee, S., Umamo, K., Shibamoto, T., & Lee, K. Identification of volatile components in basil (*Ocimum basilicum* L.) and thyme leaves (*Thymus vulgaris* L.) and their antioxidant properties. *Food Chemistry*, 2005, 91(1), 131–137. <https://doi.org/10.1016/j.foodchem.2004.05.056>
- [7] Hammad, M., Sallal, A., & Darmani, H. (2007). Inhibition of *Streptococcus mutans* adhesion to buccal epithelial cells by an aqueous extract of *Thymus vulgaris*. *International Journal of Dental Hygiene*, 5(4), 232–235. <https://doi.org/10.1111/j.1601-5037.2007.00266.x>
- [8] Karaman S, Digrak M, Ravid U and Ilcim A, Antibacterial and antifungal activity of the essential oils of *Thymus revolutus* Celak from Turkey. *J Ethnopharmacol* 76:183–186 (2001).
- [9] Kosar M, Dorman HJD and Hiltunen R, Effect of an acid treatment on the phytochemical and antioxidant characteristics of extracts from selected Lamiaceae species. *Food Chem* 91:525–533 (2005).
- [10] Lee SJ, Umamo K, Shibamoto T and Lee KG, Identification of volatile components in basil (*Ocimum basilicum* L.) and thyme leaves (*Thymus vulgaris* L.) and their antioxidant properties. *Food Chem* 91:131–137 (2005).
- [11] Lee, Y. R., Lee, H., Oh, M., Kim, Y., & Park, H. Thyme extract alleviates High-Fat Diet-Induced obesity and gut dysfunction. *Nutrients*, 2023, 15(23), 5007. <https://doi.org/10.3390/nu15235007>
- [12] Ismaili, H.; Milella, L.; Fkih-Tetouani, S.; Ilidrissi, A.; Camporese, A.; Sosa, S.; Altinier, G.; Della Loggia, R.; Aquino, R. In vivo topical anti-inflammatory and in vitro antioxidant activities of two extracts of *Thymus satureioides* leaves. *J. Ethnopharmacol.* 2004, 91, 31–36.
- [13] Sagdic, O., Ozkan, G., Aksoy, A., & Yetim, H. Bioactivities of essential oil and extract of *Thymus argaeus*, Turkish endemic wild thyme. *Journal of the Science of Food and Agriculture/Journal of the Science of Food and Agriculture*, 89(5), (2009). 791–795. <https://doi.org/10.1002/jsfa.3513>.
- [14] Consentino, S., C.I.G. Tuberose, B. Pisano, M. Satta, E. Arzedi and F. Palmas. In vitro antimicrobial activity and chemical composition of Sardinian *Thymus* essential oils. *Lett. Appl. Microbiol.*, 1999, 29: 130–135
- [15] Deans, S.G., R.C. Noble, R. Hiltunen, W. Wuryani and L.G. Penzes, Antimicrobial and antioxidant properties of *Syzygium aromaticum* (L.) Merr Perry: impact upon bacteria, fungi and fatty acid levels in ageing mice. *Flavour Fragrance J.*, 1995. 10: 323–328.
- [16] European Pharmacopoeia, 1996. Saint Ruffine: Conseil de l'Europe Maisonneuve S.A. NCCLS. (1999). National Committee for Clinical Laboratory Standards, Performance Standards for Antimicrobial Susceptibility Testing, 6th edition. Approved Standards, M2-A6, Wayne, Pennsylvania.

- [17] Agnieszka, N., Danuta, K., Malgorzata, P., & Agata, C. Effects of thyme (*Thymus vulgaris* L.) and rosemary (*Rosmarinus officinalis* L.) essential oils on growth of *Brochothrix thermosphacta*. *African Journal of Microbiology Research*, (2013) 7(26), 3396–3404. <https://doi.org/10.5897/ajmr12.1618>
- [18] Azaz AD, Irtem HA, Kurkcuoglu M and Baser KH (2004). Composition and the in vitro antimicrobial activities of the essential oils of some *Thymus* species. *J. Z. Naturforsch.*, 59(1-2): 75-80.
- [19] Babaei M, Emami-Abarghoei M, Ansari R, Vafaei AA, Taherian AA, Akhavan MM, Tosi G and Mousavi S. Antispasmodic effect of hydroalcoholic extract of *Thymus vulgaris* on the guinea-pig ileum. *J. Natural Product Sciences*, 22(13): (2008) 1143-1150.
- [20] Burt S. Essential oils: Their antibacterial properties and potential applications in foods a review. *Ind J Food Microbiol* 2004; 94(3):223-53.
- [21] Heidari Z, Salehzadeh A, Sadat Shandiz SA, Tajdoost S. Anticancer and anti-oxidant properties of ethanolic leaf extract of *Thymus vulgaris* and its bio-functionalized silver nanoparticles. *3 Biotech* 2018; 8(3):1-4. Kuete V. *Thymus vulgaris*. Medicinal spices and vegetables from Africa. 2017:599-609.
- [22] Roby MH, Sarhan MA, Selim KA, Khalel KI. Evaluation of antioxidant activity, total phenols and phenolic compounds in thyme (*Thymus vulgaris* L.), sage (*Salvia officinalis* L.), and marjoram (*Origanum majorana* L.) extracts. *Ind Crops Prod* 2013; 43:827-31.
- [23] Jain N, Sharma M. Screening of *Thymus vulgaris* essential oil against fungi causing dermatophytosis in human beings. *Int J Pharm Pharm Sci* 2017:236-9.
- [24] Prasanth Reddy V, Ravi Vital K, Varsha PV, Satyam S. Review on *Thymus vulgaris* traditional uses and pharmacological properties. *Med Aromat Plants* 2014; 3(164):2167-412.
- [25] Imelouane B, Amhamdi H, Wathélet JP, Ankit M, Khedid K, El Bachiri A. Chemical composition and antimicrobial activity of essential oil of thyme (*Thymus vulgaris*) from Eastern Morocco. *Int J Agric Biol* 2009; 11(2):205-8.
- [26] Dauqan EM, Abdullah A. Medicinal and functional values of thyme (*Thymus vulgaris* L.) herb. *J Appl Biol Biotechnol* 2017;5(2):17-22.
- [27] Vineetha. 22 Amazing benefits and uses of Thyme. *Health Beckon*. 2014.
- [28] Horvathova E, Srancikova A, Regendova-Sedlackova E, Melusova M, Melus V, Netriová J, et al. enriching the drinking water of rats with extracts of *Salvia officinalis* and *Thymus vulgaris* increases their resistance to oxidative stress. *Mutagenesis*. 2015:gev056.
- [29] Kozics K, Klusová V, Srancíková A, Mučaji P, Slameňová D, Hunáková L, et al. *Food Chem*. 2013;141(3):2198-206.
- [30] Dalle Zotte A, Cullere M, Sartori A, Szendrő Z, Kovács M, Giaccone V, et al. *Meat Sci*. 2014;98(2):94-103.
- [31] Dogu-Baykut E, Gunes G, Decker EA. *Food Chem*. 2014;157:167-73.
- [32] Dal Bosco A, Gerencsér Z, Szendrő Z, Mugnai C, Cullere M, Kovács M, et al. *Meat sci*. 2014;96(1):114-9.
- [33] Cerda A, Martínez ME, Soto C, Poirrier P, Perez-Correa JR, Vergara-Salinas JR, et al. *Food Chem*. 2013;139(1):138-43.
- [34] Oramadike CE, Ogunbanwo ST. Antagonistic activity of *Thymus vulgaris* extracts against *Vibrio* species isolated from seafood. *Journal of food science and technology*. 2017 Apr 1; 54(5):1199-205.
- [35] Eraky MA, El-Fakahany AF, El-Sayed NM, Abou-Ouf EA-R, Yaseen DI. *Parasitol Res*. 2016:1-9.
- [36] Begrow F, Engelbertz J, Feistel B, Lehnfeld R,

- Bauer K, Verspohl EJ. Impact of thymol in thyme extracts on their antispasmodic action and ciliary clearance. *Planta Med* 2010; 76(4):311-8.
- [37] Micucci M, Protti M, Aldini R, Frosini M, Corazza I, Marzetti C, et al. *Thymus vulgaris* L. essential oil solid formulation: Chemical profile and spasmolytic and antimicrobial effects. *Bimolecular* 2020; 10(6):860.
- [38] Miladi H, Slama RB, Mili D, Zouari S, Bakhrouf A, Ammar E. Essential oil of *Thymus vulgaris* L. and *Rosmarinus officinalis* L.: Gas chromatography-mass spectrometry analysis, cytotoxicity and antioxidant properties and antibacterial activities against foodborne pathogens. *Nat Sci* 2013; 5(6):729-39.
- [39] Al-Balushi AH, Aljabri M, Akhtar MS, Said S, Weli A, Airiyami Q, et al. Antibacterial and cytotoxicity activities of *Thymus vulgaris* leaves grown in Oman. *Int J Pharm Sci Res* 2013;4(11):4253.
- [40] Ramchoun M, Harnafi H, Alem C, Benlyas M, Elrhaffari L, Amrani S. Study on antioxidant and hypolipidemic effects of polyphenol-rich extracts from *Thymus vulgaris* and *Lavendula multifida*. *Pharmacogn Res* 2009; 1(3).
- [41] Fournomiti M, Kimbaris A, Mantzourani I, Plessas S, Theodoridou I, Papaemmanouil V, et al. *Microb Ecol Health Dis.* 2015;26.
- [42] Soković M, Glamočlija J, Ćirić A, Kataranovski D, Marin PD, Vukojević J, Brkić D. Antifungal activity of the essential oil of *Thymus vulgaris* L. and thymol on experimentally induced dermatomycoses. *Drug Dev Indu Pharm* 2008; 34(12):1388-93.
- [43] Vigo E, Cepeda A, Perez-Fernandez R, Gualillo O. In vitro anti-inflammatory effect of *Eucalyptus globulus* and *Thymus vulgaris*: Nitric oxide inhibition in J774A.1 murine macrophages. *J Pharm Pharmacol* 2004; 56(2):257-63.
- [44] Rezaatofghi SE, Seydabadi A, Nejad SM. Evaluating the efficacy of *Achillea millefolium* and *Thymus vulgaris* extracts against Newcastle disease virus in Ovo. *Jundishapur J Microbiol* 2014; 7(2):e9016.
- [45] Nolkemper S, Reichling J, Stintzing FC, Carle R, Schnitzler P. Antiviral effect of aqueous extracts from species of the Lamiaceae family against Herpes simplex virus type 1 and type 2 in vitro. *Planta Med* 2006; 72(15):1378-82.
- [46] Kaewprom K, Chen YH, Lin CF, Chiou MT, Lin CN. Antiviral activity of *Thymus vulgaris* and *Nepeta cataria* hydrosols against porcine reproductive and respiratory syndrome virus. *Thai J Veterinary Med* 2017; 47(1):25.
- [47] Furuhashi, M.; Koyama, M.; Higashiura, Y.; Murase, T.; Nakamura, T.; Matsumoto, M.; Sakai, A.; Ohnishi, H.; Tanaka, M.; Saitoh, S.; et al. Differential regulation of hypoxanthine and xanthine by obesity in a general population. *J. Diabetes Investig.* 2020, 11, 878–887.